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A STUDY OF THE EFFECTS OF IN-PLACE POLLUTANTS ON THE BOTTOM WATER, SEDIMENTS, AND SEDIMENT-DWELLING ORGANISMS OF THE TORONTO WATERFRONT AT THE TORONTO MAIN SEWAGE TREATMENT PLANT, 1987



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A STUDY OF THE EFFECTS OF IN - PLACE POLLUTANTS
ON THE BOTTOM WATER, SEDIMENTS, AND
SEDIMENT - DWELLING ORGANISMS OF THE
TORONTO WATERFRONT AT THE TORONTO
MAIN SEWAGE TREATMENT PLANT, 1987

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SUMMARY

A study was carried out along the Toronto waterfront in the area of the Main Sewage Treatment Plant (STP) as part of the Municipal Industrial Strategy for Abatement (MISA) program to assess the environmental impacts of contaminated sediments and the potential for accumulation of the contaminants in sediments by resident biota. Contaminant levels in bottom water, sediments, and biota were measured and sediments were also collected for laboratory bioassay experiments. A survey of benthic macroinvertebrates was conducted at the same time in order to determine whether any effects could be seen at the community level.

Elevated levels of some of the heavy metals, phosphorus, turbidity, suspended solids, and conductivity were noted in bottom waters at some stations. Conductivity was highest in Ashbridges Bay and appeared to be related to storm sewer and combined sewer discharges to the bay. Metals (Cu, Cr, Hg, Fe, Mn, and Al) were detected at greatest concentrations in bottom waters at a station close to the Main STP diffuser.

Sediment metal concentrations were highest in Ashbridges Bay where the levels of most metals were at least three times higher than at stations outside of the bay. Sediment copper, chromium, mercury and lead concentrations exceeded the Severe Effect Levels of the proposed Provincial Sediment Quality Guidelines. The Main STP appears to be contributing to higher sediment levels at those stations near Ashbridges Bay. In most cases however, the STP did not appear to be the only source. Outflow from Ashbridges Bay as well as lakefilling activities in the area may be contributing to the sediment contaminant levels. Sediment metal concentrations were generally higher in those areas with high organic enrichment as measured by Total Organic Carbon (TOC). Strong statistical correlations between organic carbon and metal levels suggest accumulation occurs through binding to organic particles.

Temporal changes in sediment metal concentrations generally varied according to changes in the sediment organic carbon levels. Stations were all located in the near-shore zone, a high energy environment where bottom sediments would be subject to continuous erosion. Due to current and wave action, distribution of fine sediments and hence contaminants was patchy except for Ashbridges Bay and areas adjacent to the Eastern Headland lakefill.

Geochemical studies of the sediments indicated that at those stations closer to the shore, a higher percentage of the metals Cd, Cr, Cu, and Zn were in the organic bound fraction than at stations further offshore. In the offshore stations, the metals were distributed mainly in the Fe/Mn oxide/hydroxide and residual fractions.

Organic contaminants were generally below detection limits with the exception of PCBs and a number of PAH compounds. Both appear to originate from urban runoff and could not be linked to any specific source. The highest levels of PCBs and PAHs were in, and adjacent to, Ashbridges Bay and were strongly correlated with oil and grease levels in the sediments.

Accumulation of metals by benthic organisms is apparently mediated by the presence of organic matter in the sediments. Only tissue levels of copper and lead were higher in organisms collected in Ashbridges Bay than outside of the bay. Levels of other metals were similar throughout the study area. The ratio of tissue to sediment concentrations suggests that sediment organic matter strongly influences metal availability from the sediments. Though tissue levels did not vary greatly among stations, invertebrates at those stations where sediment organic matter was low accumulated metals to higher concentrations than in other sediments.

Organic contaminants generally were not detected in invertebrate tissues. Despite the high sediment levels of PAHs, tissue levels were below detection limits. Sediment deposits of oils and grease appear to control availability of these compounds.

Higher levels of PCBs in invertebrate tissues compared to sediment levels were detected and availability of PCBs from the sediments also appeared to be controlled by sediment organic matter. Accumulation in tissue to levels higher than in sediments (in some cases as much as 2 to 3 orders of magnitude higher) occurred mainly at those stations low in organic carbon.

Based on current knowledge it is extremely difficult to formulate any mechanistic explanations for the uptake of contaminants by biota. As a result, it is not possible to determine whether sediment or water is the principal route of contaminant uptake in organisms. However, it is apparent that sediments are acting as a reservoir for many contaminants which in turn are contributing to organism tissue levels.

Sculpin (a bottom-feeding fish) tissue levels did not demonstrate any clear pattern of contaminant accumulation. Differences in metal tissue residues among stations was small, and could not be related to either sediment levels or water concentrations.

Sculpin tissue levels of organic compounds (a-BHC, dieldrin, endosulfan sulphate and pp-DDE), when normalized for lipid content (body fat), did not show any appreciable differences between stations. Accumulation appears to be occurring throughout the study area and is most likely related to a combination of water, sediment, and contaminated food sources (i.e. benthic invertebrates).

Since sculpins are exposed to contaminants in both the water and the sediments, determination of the relative contribution of contaminants from sediment reservoirs is problematic. Benthic invertebrates, particularly the in-fauna, would therefore be a more suitable organism for determination of availability of contaminants from sediments.

Sediment bioassay experiments yielded high mortality among fathead minnows in some sediments. These were also most often sediments lower in organic carbon content (contaminant levels were essentially the same). Mortality was low at those stations where sediment organic content was high (including Ashbridges Bay, where sediment contaminant levels were highest) despite the often higher sediment contaminant levels at these stations. Mortality among mayfly nymphs was generally low and in all cases much lower than among the minnows. No specific contaminants could be identified as a possible cause for the mortality among the fathead minnows. Since no corresponding mortality was evident among the mayflies, determination of sediment toxicity remains inconclusive.

Studies of the benthic invertebrate community indicated that sediment type, rather than contaminant levels, had the greatest effect on species composition and density of organisms. Diversity was reduced in areas of high organic enrichment, though density of organisms was high. However, diversity was also reduced at nearshore stations low in organic matter and suggests the presence of a contaminant effect. Slightly more diverse faunas were noted at offshore stations with moderately high organic carbon content. Both density and diversity were low in Ashbridges Bay, where the benthic fauna also seemed to be affected by contaminant levels.

The effects of sediment contaminants on aquatic biota in the area of the Toronto Main STP outfall were most apparent where sediment organic matter was low. This suggests that contaminant levels are generally sufficiently high to have some effect on aquatic organisms, but that these effects are strongly mediated by the presence of organic matter, including oils and greases.

In the vicinity of the STP discharge, a number of other sources, such as the outflow from Ashbridges Bay and washdown of fill materials from the lakefills also appear to be contributing to the overall contaminant input, making it difficult to isolate specific impacts/contributions from the STP.

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1. INTRODUCTION

A study was carried out along the Toronto waterfront in the vicinity of the Main Sewage Treatment Plant to determine the environmental impacts of contaminated sediments. The study was undertaken as part of the Municipal-Industrial Strategy for Abatement (MISA) Pilot Site program. Studies have shown that sediments may act both as a sink for contaminants and as reservoirs for future release to the water column. Contaminants in sediments can also potentially affect aquatic organisms. An understanding of the movement of contaminants into and from sediments is an important factor in predicting their long-term fate and effects in the aquatic environment.

In an effort to understand the biological significance of contaminants in sediments, the Ministry has developed an ecosystem approach for assessing sediments. This approach investigates the physical, chemical and biological aspects of sediment contamination. Physical studies provide information on the type of sediment, while chemical investigation provides information on contaminant levels in bottom water, sediments and the aquatic biota that inhabit sediments, including the bottom-feeding predators. The biological component can provide indications as to fate and movement of contaminants in biological compartments and their effects on the organisms. The latter are often determined at the community or population level rather than effects on individuals.

In order to determine if the Main STP is a major source of contaminants, the study sought to establish the extent of contamination of the sediments through measurement of the sediment concentrations of metals, organochlorine pesticides, PCBs, PAHs, and chlorinated aromatics. Concentrations of these were also determined in the overlying water and resident biota (benthic invertebrates and fish) in order to assess the nature and extent of contaminant movement from the sediments, and to identify whether contaminants in sediments were adversely affecting aquatic organisms.

2. METHODS

Between July 7-22, 1987, twelve stations were surveyed in the vicinity of the Main STP outfall. The survey was undertaken by the Aquatic

Biology Section of the Water Resources Branch as part of its In-Place Pollutants Program. The stations were located in Ashbridges Bay, at the STP outfall, and adjacent to the Ashbridges and Eastern Headland lakefills (Figure 1).

The study components included: surficial sediment chemistry (top 5 cm), bottom water (1 meter off bottom) chemistry, contaminant levels in benthic invertebrates (oligochaetes and chironomids) and bottom-dwelling fish (sculpins), and benthic enumeration studies. In addition, the fine-sediment fraction (<63 μ diameter) was analyzed using an operationally defined sequential extraction scheme to determine the distribution of metals in the various geochemical phases (Persaud *et al.* 1987).

Bottom-water samples were collected 1 m off the bottom with a Van Dorn sampler on the last day of each field survey, water temperature and dissolved oxygen were measured and the sample was properly preserved according to the type of analysis required and submitted to the MOE laboratory. Samples were analyzed for nutrients, ions, metals, PCBs, organochlorine pesticides and chlorinated aromatics.

Sediment was collected with a 9" x 9" (22.9 cm x 22.9 cm) stainless steel Ponar grab sampler. The top 5 cm of sediment from each of three Ponar samples were collected at each station and composited for sediment analysis. Most physical measurements were carried out in the field in accordance with the methods described in Persaud *et al.* (1987) and included sediment pH, redox potential, and sampling depth. Sediments were maintained at 4 C until analyzed.

Chemical analyses on sediment and bottom water were carried out in the MOE laboratory in accordance with procedures described in OMOE (1983). Sediments and bottom water were analyzed for nutrients, metals, PCBs and pesticides, PAHs, chlorinated aromatics, and sediment particle size.

Benthic organisms for contaminant analysis were also collected by Ponar sampler. A minimum of 2 gm of the most abundant organism was collected at each station for inorganic contaminant analysis, wrapped in plastic and immediately frozen. An additional 4-5 gms was collected for organic contaminant analysis, wrapped in hexane rinsed foil and frozen. These were analyzed for PCBs, pesticides, PAHs and chlorinated aromatics as well as lipid content and ash. The percent ash was used

to correct for gut content in determining tissue concentrations. Analyses were carried out by private laboratories according to the methodologies described in Persaud *et al.* (1987) and OceanChem (1988).

Sculpins (approximately 6-10 cm total body length) were collected by divers equipped with handnets from either natural substrates (gravel), or, where substrate conditions were unsuitable (e.g., Ashbridges Bay), by traps. The traps consisted of two patio stones bolted together and lowered to the bottom. At each station a minimum of 15 sculpins were collected for tissue analysis. Sculpins from each station were grouped by species, (according to Godkin *et al.* 1982), age and length. The chemical analyses were the same as those for benthic invertebrates.

A total of 5 replicate samples for benthic invertebrate community analysis were collected at each station using a Ponar grab sampler (22.9 cm x 22.9 cm (9" x 9")). Samples were field washed using a U.S. 30 mesh (595 μ m) sieve and the residue was preserved in plastic containers in 5-10% neutralized (with borax) formalin solution. Samples were sorted under a dissecting microscope. The densities of organisms were averaged over the total number of replicates and the replicate closest to the mean values was chosen for detailed identification of the organisms present. The remaining four samples were set aside for biomass determination.

Biomass estimates were calculated as preserved wet weight of organisms. Samples were blotted dry on filter paper to remove surface moisture and were immediately weighed to the nearest 0.1 mg on a Mettler H20T balance. The results were averaged over the number of replicate samples and the mean value has been presented in the tables. A correction factor of 10% has been added to the total preserved weight to attain the total live wet weight. Studies by Wiederholm and Eriksson (1977) and Landahl & Nagell (1978) have shown that on average a 10% weight loss occurs in preserved specimens due primarily to differences in densities between ethanol and water.

Laboratory bioassay experiments were conducted on sediments collected during October 6 to 13, 1987 from each of the 12 stations sampled (Figure 1). Sediments were stored at 4° C. Part of the sediments collected was used for analysis of the same chemical parameters measured in July. On October 16, 1987, the sediments were sieved through a 3 mm mesh sieve prior to use in the

bioassay to remove large particles and debris as well as homogenize the sediment. A total of 200 mL of sieved sediment was placed in a 1 L Mason jar to which was added 800 ml of dechlorinated tap water. Six jars were filled for each station and the sediments were allowed to settle for 24 hrs. before aeration was started. After 1 hr of aeration, test animals were added to the jars. The six test jars for each station were divided into two groups of three jars each. Five fathead minnows (*Pimephales promelas*) were added to each of the three jars in the first group and five nymphs of the burrowing mayfly *Hexagenia limbata* were added to each of the three jars in the second group. The minnows used were cultured in the MOE Rexdale laboratory and were all 3 months of age. The mayflies were second year nymphs collected at Honey Harbour (an uncontaminated site) on Georgian Bay. Honey Harbour sediments were used for the experimental control.

The bioassay was run for a total of ten days in a controlled water bath at 20°C and was monitored daily for any mortality at which time any dead animals were removed. At the end of the ten day period the surviving animals were removed, frozen, and subsequently submitted for analysis of tissue contaminant levels. In order to obtain sufficient biomass for tissue analysis, the surviving mayflies from all three replicates were pooled. One replicate for fathead minnows (greatest number surviving) was selected for analysis.

3. RESULTS

3.1 Bottom Water

Bottom water was collected at all stations sampled for sediments and biota in 1987. The results are presented in Tables 1 through 4.

Turbidity and suspended particulates were highest at station 0003, located near the Main STP outfall. Boyd (1988) and Poulton and Beak (1989) noted that increased turbidity and suspended matter in the water column have been associated with discharges from the STP in the past. Levels of both were also higher at station 0001, adjacent to the Ashbridges lakefill, than at the stations located furthest out into the lake. Studies on the movement of contaminants from the Main STP indicate that contaminants from the discharge disperse omnidirectionally from the diffuser outfall (station 0003) and that the greatest effect is apparent in the

surface waters in the area of station 0001 and 0005. Movement of the plume seems to be affected mainly by wind generated wave action, and studies of water concentrations of contaminants show the highest concentrations are usually confined to an area bounded by the Eastern Headland and the Ashbridges Lakefill (Beak 1989).

Ashbridges Bay receives input from storm sewers and combined sewer overflows at the north end of the bay. Both factors could affect the turbidity and suspended sediment levels in the bay. Resuspension of settled material is also likely to be high, especially during rainfall events, given the shallow nature of the bay. During storm events, potential exists for backwash into Ashbridges Bay, especially during lake seiche events. Most water quality parameters were significantly higher in Ashbridges Bay than at stations outside of the bay (Table 1). Conductivity in Ashbridges bay was 1.45 times higher than the mean levels in the open-lake stations, while sodium and potassium were 2 times higher.

The Main STP was identified as a source of phosphorus (P) to the surrounding water by both Boyd (1988) and Poulton and Beak (1989), though both studies indicated that levels near the surface were higher than in bottom water. During this survey, levels of P in the bottom water were highest at station 0003, followed by Ashbridges Bay. These higher concentrations, at least at station 0003 and 0005, appear to be primarily related to discharge from the STP and not sediment release. Sediment P and organic carbon levels were actually highest in Ashbridges Bay, while considerably lower levels were found at station 0003 and 0005. Sediment pH and redox potential (Eh) differed little between station 0008 and 0003 (Table 6) and release rates from sediment should therefore be similar as well, suggesting that the higher P levels at station 0008 should not be due to higher rates of release from the sediments.

Levels of copper, chromium, mercury, iron, zinc, and aluminum in the water column were highest at station 0003 (Table 2). Iron and copper were found by Poulton and Beak (1989) to be associated with treated effluent discharges from the STP and the high water concentrations noted during this survey were likely due to this source as well. This probably also holds true for the higher mercury levels in bottom water at station 0003. The distribution of metals in bottom water among the different stations shows a similar pattern to that noted by Beak, suggesting that the plume affects

metal levels at stations 0005 and 0001. Levels of metals in bottom water at station 0008 (in Ashbridges Bay) were approximately the same as levels in the open-lake stations, further suggesting that sediment release of metals to the water column is minor. Sediment metal concentrations were highest in Ashbridges Bay and sediment physical measurements such as redox potential indicate that release rates should be similar to stations 0003, 0005 and 0001.

The STP does not appear to contribute detectable levels of organics to the bottom water (Tables 3 and 4). The presence of hydrophobic compounds in water can usually best be seen in the cumulative build-up of levels in the sediments, since these compounds generally bind rapidly to organic matter and settle in the sediments in this matrix. Sediment levels at stations 0003, 0005 and 0001 were all below detection limits and indicate that potential release to the water column is not significant.

The main effects of the STP discharge on bottom water therefore seem to be slightly elevated levels of P, some of the heavy metals, suspended solids and turbidity. The effect appears to be confined to the area bounded by the Eastern Headland and the Ashbridges Lakefill.

3.2 Sediments

Sediments are often the primary reservoir for contaminants discharged in effluents. Many metals and organic compounds will bind or partition to particles in the water column and subsequently settle to the bottom (Sigg *et al.* 1987; Smith *et al.* 1988). The distribution of contaminants in sediments is therefore the sum product of effluent concentrations (from all effluent sources), current and wave action, suspended particle concentration and sorption characteristics.

3.2.1 Physical Characteristics

Organic content of the fine-sediments is probably the most important factor affecting contaminant distribution within an area. The two surveys of July-August and October, as well as other studies, show that the distribution of organic matter and the distribution of fine sediments in this area of the Toronto Waterfront was both seasonally, as well as spatially, variable (Table 5). Considerable seasonal variation in substrate type was noted at the mouth of Ashbridges Bay Lakefill embayment (station 0005) and the deeper stations in the open lake (stations 0012, 0006, 0011, 0007, 0009). As

shown in Figure 2, the extent of fine sediment accumulation changed seasonally, with a more extensive area of silty sediments during the summer sampling months and a larger area of predominantly sandy sediments in the fall. The whole of the near-shore area is a high-energy environment (Poulton, Pers. comm.) subject to strong erosive wave action. Seasonal changes in sediment composition, therefore, are likely due to changes in wind/wave direction and current movement. Sediment organic matter has been observed to occur in pockets, generally in depressions in the bottom (A. Hayton, Pers. Comm.). These can also shift in response to the effects of current and wave action.

Ashbridges Bay is shielded by the lakefill headlands and the narrow opening of the bay from the erosive forces that affect sediment distribution outside of the bay. As a result, an area of very silty sediments remained concentrated in Ashbridges Bay throughout the study period.

Outside of Ashbridges Bay, the extent of sandy sediments was generally greater in October compared to the summer months and only near the southern half of the Eastern Headland (station 0002 and 0004), and at the Ashbridges Lakefill (station 0001), were sediment types similar (predominantly sandy sediments) during both sampling seasons. The reduction in the extent of the silt distribution during October is likely due to the increased wave action as a result of higher frequency of storm events (Poulton, Pers. comm.)

Sediment redox potentials as measured by Eh (Table 6) indicate that anoxic conditions prevailed at sediment depths of 3 cm at all stations except station 0004. Strongly negative Eh values indicative of anoxia were found at the shallow water depths in and adjacent to Ashbridges Bay, and are probably related to organic matter decomposition.

3.2.2 Sediment Metals

Sediments in the study area were highly variable in sand and organic content and this variability appeared to affect the contaminant levels in the sediments. Accumulation of some contaminants, such as the metals, is due at least in part to plume movement from the Main STP. Copper, zinc, iron and manganese concentrations in surface water were higher in and adjacent to Ashbridges Bay, though the highest surface water concentrations occurred in Ashbridges Bay (Poulton and Beak 1989) and are likely due to the sources

discharging directly into the bay, and not the STP. Poulton and Beak (1989) noted PWQO exceedances for Fe, Cd and Cu in surface waters near the STP outfall, suggesting that the STP is a significant source of these contaminants to areas outside of Ashbridges Bay. Confinement of the plume to the area bounded by the Ashbridges and Eastern Headland lakefills, as indicated by Poulton and Beak (1989), has likely contributed to the higher sediment levels of those contaminants associated with loss from the STP (in part through losses and subsequent deposition of suspended solids). The same holds true for Ashbridges Bay, where inputs from storm sewer discharges have contributed to high contaminant concentrations in the sediments. The distribution of contaminated sediments indicates that these have accumulated in Ashbridges Bay to considerably higher levels than at locations outside of the Bay. Sediment concentrations of copper, chromium, mercury and lead at station 0008 exceeded the Severe Effect Level of the draft Sediment Quality Guidelines (Persaud *et al.* 1990). The Severe Effect Level is considered the level at which pronounced toxic effects on the benthic community can be expected. Only the most tolerant organisms are expected to be able to survive under such conditions.

The strong correlation between bulk sediment metal concentrations and the sediment organic matter content (as measured by TOC) show that the distribution of metals in sediments is related primarily to sediment organic matter (Figures 3 and 4). Therefore, no simple relationship seems to exist between sediment metal concentrations and distance from the STP outfall, though this may in part be due to the large number of potential sources in this area (i.e., the STP outfall, urban runoff, loss of fill materials from the Eastern Headland and Ashbridges Lakefills). Sediment concentrations of all metals were consistently higher in those sediments high in organic carbon (TOC), and all were significantly correlated (Spearman Rank Correlations) with TOC during one or both of the July-August and the October surveys (Table 26). Bulk sediment metal concentrations were highest in Ashbridges Bay and decreased outside of the bay. Levels near the Ashbridges Lakefill (stations 0005 and 0001) were generally lower in July-August than in October and reflected the lower organic carbon content of the sediments during the summer survey. Though sediment metal concentrations at station 0005 were higher during October than in July-August, concentrations were still lower than in Ashbridges Bay (station 0008), despite similarly high sediment

organic carbon levels. For example, levels of Cu, Hg, Cd, Pb, Al and As were at least twice as high at station 0008. The levels of Cu, Cr, Cd and Pb at both stations 0008 and 0005 exceeded the Lowest Effect Level guidelines of the proposed Provincial Sediment Quality Guidelines (Persaud *et al.* 1990). The Lowest Effect Level is the level at which contaminants may adversely affect some sensitive benthic organisms. Sediment TOC and solvent extractables at station 0008 were either slightly higher (TOC) or lower (solvent extractables) than at station 0005. Sediment concentrations therefore suggest that Ashbridges Bay has received inputs of metals from the storm sewers and combined sewer overflows discharging into the bay. These contaminants have subsequently accumulated in the fine-grained sediments of the Bay.

Ashbridges Bay sediments have accumulated significantly higher levels of metals than comparable sediments outside of the bay. The erosive action of waves and current appear to be the most likely reasons for the much lower levels of contaminants outside of Ashbridges Bay. The shifting of sediment types shows that current and wave action play a significant role in the distribution of contaminated sediment through resuspension and deposition in lower energy environments (the deeper areas of the lake).

Bulk sediment metal concentrations at station 0003, located near the STP diffuser, were comparable to other areas outside of Ashbridges Bay. The Poulton and Beak (1989) report indicates that surface water concentrations of a number of metals, as well as ammonia and conductivity were higher in this area. Sediment metal concentrations at station 0003 were very similar to concentrations at stations 0001 and 0005 during both the summer and fall surveys and levels varied little despite a minor increase in sediment TOC in October.

Sediment metal concentration at those stations further out into the lake appeared to vary according to sediment TOC levels. During the July-August survey, higher levels of metals were found in sediments at station 0012 and 0009 (consistent with the higher levels of sediment organic carbon) than at stations 0010, 0002 and 0004, where sediment organic matter and silt content were lower. The considerable decrease in sediment contaminant levels from July-August to October at stations 0009, 0012, and the increase in sediment contaminant levels at stations 0010 and 0007 during this period parallel the changes in sediment type and organic content and serve to demonstrate the

affinity of metals for the organic fraction of the sediments. Overall, sediment metal levels were lowest at station 0004, most likely due to the almost exclusively sandy sediments, low in organic carbon.

The effect of the STP discharge does not appear to be localized. The dispersal of the effluent plume, in conjunction with the continual resorting of sediment matter, serve to disperse contaminants throughout the study area, and, through erosional forces, to deeper areas outside of the present study area. Outwash of sediments from Ashbridges Bay and erosion from lakefill operations are also dispersed in a similar fashion to be mixed with contaminants from the STP.

3.2.3 Geochemical Fractionation

Metals will often bind preferentially to different components of the sediment. The sequential extraction scheme is an operationally defined process that separates the various components in the fine-particle (<63 μ) fraction. The concentration of metals can be measured in each of the following geochemical phases:

IW - Interstitial Water

F1 - Cation Exchangeable Fraction

F2 - Easily Reducible or Carbonate Bound

F3 - Organic Complex

F4 - Fe/Mn Oxide Fraction

Res- Residual Fraction

The significance of each fraction is discussed in Persaud *et al.* (1987) and Tessier (1979). The results of the geochemical extraction procedure are presented in Table 7 and Figures 5 through 14 (data for station 0004 are lacking since sufficient sediment in the <63 μ fraction could not be obtained).

The geochemical distribution of aluminum (Table 7 and Figure 5) shows that the largest concentration was found in the Residual fraction of the sediments and that levels between stations varied only slightly. This is consistent with a geologic origin. The organic fraction (F3) seems to play a minor role in sediment accumulation of aluminum.

Total Arsenic in bulk sediments showed a much greater range of variation in levels, though the relative amounts in each of the geochemical fractions remained constant (Figure 6). Over 50% of total sediment As was bound in the Residual and F4 fractions, with only minor amounts in the other fractions. Arsenic levels were highest in bulk sediments in Ashbridges Bay (station 0008) and at

stations 0002 and 0009 though concentrations exceeded the Lowest Effect Level of the proposed Provincial Sediment Quality Guidelines (Persaud *et al.* 1990) only at station 0008. The higher levels at the latter two do not suggest that arsenic is accumulating in these sediments simply as a result of discharge from the STP but suggest accumulation from a number of sources of input.

Chromium, copper, lead, and mercury levels were very high in sediments at station 0008 and levels of each exceeded the Severe Effect Levels of the proposed Provincial Sediment Quality Guidelines in July-August. The Severe Effect Level is the concentration at which a contaminant is expected to affect all but the most tolerant benthic organisms. In addition, zinc concentrations exceeded the Severe Effect Levels in the October survey. Sediment concentrations outside of Ashbridges Bay at stations 0001 and 0005 were also high, though only copper and chromium concentrations exceeded the Severe Effect Levels at station 0005 in October. However, lead, zinc, nickel, cadmium, copper and chromium all exceeded the Lowest Effect Levels of the proposed PSQGs in at one or both of these stations during the two sampling periods. Copper and chromium levels exceeded the Lowest Effect Level Guidelines at all stations except 0010, 0002 and 0004.

Bulk sediment concentrations of lead, zinc and cadmium generally decreased with distance from the shore though this was modified by sediment organic matter content such that those stations characterized by low sediment organic content (stations 0002 and 0004) had lower bulk sediment levels. Except for lead, concentrations of these metals at those stations closer to the STP outfall were highest in the F3 (organic-bound) fraction, indicating that sediment organic matter is the major repository of these metals (Figures 7, 8, 9, 11 and 14). Stations 0007 and 0011, both of which were located in open water, generally had the lowest levels in the F1 to F3 fractions, with higher levels in the F4 and residual fractions.

Andrews (1988) observed the movement of zinc in sediment fractions over time and noted that increased residence time leads to an increase in the residual fraction, suggesting the metal moves through the less tightly bound fractions into the residual fraction. The presence of higher metal levels in the F3 fraction suggests that the origin of these metal concentrations is comparatively recent. The higher concentrations in the F3 fraction also has implications for bioaccumulation of these metals

and these are discussed in the next section.

Iron and manganese were distributed in sediments in a similar pattern to the other metals during the July-August survey, with highest bulk sediment levels recorded in Ashbridges Bay. Higher levels persisted outside of the bay at those stations where sediment organic content was higher, such as stations 0001, 0005, 0012 and 0009. Iron was generally found mainly in the residual fraction and, as expected, the F4 fraction (Figure 10). Levels in other fractions were low. Manganese was broadly distributed among all sediment fractions at the various stations, though the largest single concentration was consistently in the residual fraction (Figure 13). However, Mn did increase in the more available fractions (F2 and F3) at stations 0008 and 0002.

All bulk sediment metal levels increased slightly from July-August to October in Ashbridges Bay (station 0008) and paralleled the increase in sediment TOC during this period. However, while sediment TOC levels fell from 16.0 mg/g to <5.0 mg/g at station 0001 during this period, only slight changes in sediment metal levels were apparent and suggests that metals were accumulating not just in conjunction with organic matter. A local source appears to be contributing higher contaminant levels to the sediments. Stations further out in the lake (stations 0012 and 0009) which showed significant reductions in TOC levels in October also had significant reductions in sediment metal levels as well. Geochemical fractionation data showed that the fluctuations in levels of Cd, Cr, Cu, and Zn among stations occurred primarily as changes in the concentrations held in the F3 or organic-bound fraction.

3.2.4 Organic Compounds

Organic contaminants were generally present in sediment only at very low concentrations (below detection limits) (Tables 8 to 10). Levels of PCBs and pesticides (mainly organochlorine compounds) were present at or below detection limits, though a few parameters (*a*-chlordane, *g*-chlordane, dieldrin, PCBs and DDT and its metabolites) were present at concentrations above detection limits inside Ashbridges Bay (station 0008) in July-August (Table 8). Sediment concentrations of all of these compounds exceeded the Lowest Effect Levels of the proposed Provincial Sediment Quality Guidelines, indicating that the existing sediment in Ashbridges Bay could be detrimental to

some sensitive benthic organisms. Levels outside of Ashbridges Bay were below detection limits. A slight increase in sediment concentrations was apparent in October at station 0008, though levels of most remained below detection limits outside. The exception was PCBs, levels of which increased at stations 0005 and 0001, both close to the mouth of Ashbridges Bay. Sediment PCB concentrations in October did not correlate (Spearman Rank) well with sediment TOC levels, though they did correlate significantly with levels of solvent extractables ($r = .6756$ (.0251)), and suggests that PCBs are being deposited in sediments primarily through preferential solubility in oils.

Distribution of PAH compounds in sediments was similar to the contaminants already discussed and levels of total PAHs were highest in and near Ashbridges Bay (stations 0008, 0005, and 0001) (Table 9). Sediment concentrations at all three of these stations exceeded the Lowest Effect Level guidelines for total PAH (Persaud *et al.* 1990), indicating some impairment of the benthic community was likely as a result of sediment contamination by PAH compounds. Only one PAH compound, fluorene, was present at higher concentrations in sediments at station 0008, while concentrations of all others were highest at station 0005. The accumulation of PAH compounds in sediments has been linked to the accumulation of fine-grained (silty) sediments (Umlauf & Bierl 1987). The distribution of total and individual PAHs in sediments could not be related to either sediment grain size or organic carbon content and is most likely a factor of proximity to sources (Figure 18). Urban runoff has been suggested as a significant source of PAH compounds to sediments (Wakeham *et al.* 1980) and sources such as storm sewers may contribute significant amounts to sediments. Levels of PAHs in sediments were higher at those stations close to the lakefills (0005, 0001, 0002 and 0004) relative to those stations further out, despite the lower sediment organic content of the former. The highest sediment concentrations of PAHs were in and adjacent to Ashbridges Bay and this distribution pattern strongly suggests that runoff, either directly (from contaminated fill in the case of those areas near the lakefill) or through storm sewer discharge (in the case of Ashbridges Bay and adjacent areas) is the major contributor of PAHs to sediments. Correlation (Spearman Rank) of total PAHs with levels of oil and grease suggest these as the major sediment reservoirs of PAHs ($r = .7552$ (.0122)). Urban runoff as the major source of PAHs seems to be the only plausible explanation for the sediment accumulations, since specific sources of PAHs such

as smelting, oil refining and coal storage are not present in this area of the waterfront. The unstable nature of the sediments in the nearshore areas suggest that effects from historical uses, such as coal burning for fuel at the Hearn Generating Station are not likely to persist for any extended period of time. Sediment concentrations of total PAH (sum of all PAH compounds in Table 9) exceeded the Lowest Effect Level of the proposed PSQG at all stations except 0010, 0007, and 0011 (Fig. 17). The highest Total PAH concentration of 93.4 ug/g occurred at station 0005. The Severe Effect Level of the proposed PSQGs for this sediment (based on a TOC of 11 mg/g) was 110 ug/g. Sediment concentrations, as measured by Total PAH were also high at stations 0008 and 0001 (Figure 17) and show that contamination in and around Ashbridges Bay is high.

Levels of other chlorinated organics were all below detection limits at all stations and no apparent accumulation in sediments seems to occur for these compounds (Table 10). Levels in the water column were also low.

Accumulation of PCBs and the PAH compounds seems to be related to local sources, primarily urban runoff through storm sewer and combined sewer discharges, and not to atmospheric deposition. The distribution pattern suggests that both the storm sewer discharge at Ashbridges Bay and the Main STP may be contributing to elevated levels in sediments since the areas of impact of these sources overlap. Distribution of these compounds in sediments could not be related to any one source, considering the number of potential sources in the study area. However, the Main STP does appear to be a contributor to contaminated sediment problems.

Solvent extractable levels were generally high at nearshore stations, though these do not appear to contribute to the sediment TOC levels (correlations between sediment TOC and solvent extractables were not strong (Table 26)). It is unlikely that solvent extractables are a major component of the sediment organic carbon, since changes in TOC levels at stations 0008 and 0005 over the two sampling periods were not accompanied by changes in the levels of solvent extractables. In fact the opposite occurred with TOC levels increasing while levels of oils and grease fell. This is illustrated by a decrease in solvent extractables from 13,510 ug/g at station 0008 in July-August to 2,788 ug/g in October, while TOC levels at this station increased from 63.0 mg/g to

67.0 mg/g. Similar results were noted at station 0005. Solvent extractables were highly correlated with sediment metal levels for some of the metals (Table 26) and may be one mode of metal deposition in sediments. They may also act as a reservoir or sink for these metals once deposited.

While the presence of higher sediment contaminant concentrations in study area can be readily demonstrated, delineating the sources and their relative contributions to the sediment contaminant levels at any one station is much more difficult. Poulton (pers. comm.) applied a ratio-matching/cluster analysis technique (Poulton, 1989) to the data in Table 6 (excluding aluminum and solvent extractables (October)) and identified four zones of impact (Figures 20a and 20b). Poulton (pers. comm.) identified zones 1 and 2 as being affected by storm sewer discharges and a combination of outflow from Ashbridges Bay and erosion from the lakefill, respectively, while zone 3 was identified as the area most affected by the plume from the STP. Zone 4 was considered to be most impacted by the lakefills and 'general lake effects'.

Contaminant sources in Ashbridges Bay are undoubtedly the simplest to define since the storm sewers are the only major dischargers into the Bay. In contrast, three potential sources are affecting those stations along the Ashbridges Lakefill. These are, outflow from Ashbridges Bay, the STP discharge, and erosion from the lakefill itself. Stations further out are also affected by these sources, though to a lesser extent. The picture becomes even more complicated at the offshore stations since in addition to input from the sources identified above, contaminated sediments from the near-shore areas can be resuspended and at least temporarily deposited in these deeper areas.

3.3 Aquatic Biota Contaminant Analysis

3.3.1 Benthic Invertebrates

The geochemical distribution of metals in the sediment can directly influence the availability of the metals to aquatic organisms. Studies (Luoma 1983; Smock 1983) have suggested that 80 to 85% of an organisms body burden may be acquired by adsorption of metals through the integument or cuticle (Knowlton *et al.* 1983) and that the free ion concentration in the interstitial water is usually the most available form. However, sediment concentrations may contribute 20% or more of body

burden, depending on the availability from the sediments. While uptake efficiency has been shown to be considerably greater from water than from ingested matter, in areas of high sediment concentrations of contaminants, ingestion may contribute significant amounts to an organisms body burden.

Sorption of contaminants by sediments and desorption to the water phase are believed to be continuous exchange processes (Stumm & Morgan 1981). Levels of metals and organic compounds available to biota from the water phase would therefore depend on levels available in the solid phases of the sediments. As such, in areas of contaminated sediment, even minute concentrations in the interstitial or bottom water could contribute significantly to an organisms body burden.

Metal accumulation by benthic biota appears to be a complex process influenced by a large number of factors, and tissue levels are the sum of adsorption from the water, desorption from the sediment and absorption from ingested matter. Depending on sediment characteristics, the amount contributed from each of these processes can vary. It is generally recognized however, that the most efficient means of uptake is through adsorption of free ions from the water column or those desorbed from the sediments. Desorption of metals is itself a complex mechanism affected by a number of physical and chemical factors such as pH, redox potential (Eh), and the type of sediment (organic matter, Fe/Mn oxides, clay minerals, and particle size).

Correlation analysis (Spearman Rank Correlation) between tissue metal levels and the amounts held in the various geochemical fractions yielded poor correlations between tissue residues and all sediment geochemical fractions (Table 27). Metals held in the solid fractions (F1 to F4) are generally considered to be potentially available to aquatic organisms (Persaud *et al.* 1987). Availability decreases somewhat from the F1 to the F4 fraction as binding strength to the sediments increases and release potential to the water (mainly the interstitial water) decreases. Metals bound to the F4 fraction (Fe/Mn oxides/hydroxides) are usually unavailable except under reducing conditions (Stumm & Morgan 1981). Metals held in the organic fraction, though potentially available, can also be tightly bound and may not be easily removed under the chemical conditions in the gut of most benthic organisms (Luoma 1983). Nevertheless, metals held in the F1 to F3 fractions are potentially the most

available to benthic organisms, since these are the most readily extractable.

Metals held in the residual fraction are usually not available to benthic organisms nor are they readily released to the water. These are the most tightly bound metals, occurring within the crystal lattices of minerals (clays etc) and are not available under natural conditions.

Since in the case of metals 15-20% of an organism's body burden can be acquired through ingestion of contaminated sediments, the presence of contaminants in the more readily available fractions could serve to facilitate uptake and tissue concentration by means of digestive processes. The presence of metals in these fractions could also serve to increase the availability of these metals in the interstitial water.

Biota-sediment concentration ratios (since biota tissue residues are derived from both sediment and the water column the term bioconcentration has been avoided) are presented in Table 12. For sediment in-fauna this ratio can be used as an expression of the availability of contaminants from the sediments. A high ratio denotes that tissue residues were higher than sediment concentrations and suggests that availability from these sediments is high. It must be borne in mind however, that a high concentration ratio does not necessarily imply high tissue levels but merely measures tissue levels relative to sediment levels. For most metals these ratios varied inversely with sediment organic matter content, suggesting that organic sediment effectively binds contaminants, thus reducing their availability to benthic organisms. Despite the generally low concentration ratios obtained for samples from Ashbridges Bay, total invertebrate tissue levels of some metals (Cu, Cr, Fe and Pb) were actually highest in Ashbridges Bay. Tissue residues were lowest at station 0006.

In general, metal levels in benthic organism tissues correlated poorly with sediment levels for both bulk sediments and the geochemical fractions. Benthic organism tissue residues could not be related to levels of contaminants in the water column, in part because levels in the latter were generally very low. Other studies have indicated that metals tend to bind to organic matter and iron/manganese oxides in the water column and that most of the contaminant load is rapidly transported to the sediments (Sigg *et al.* 1988).

Tissue residues of individual metals

appeared to be related primarily to local availability. For many of the metals tissue residues fluctuated widely, and were apparently unrelated to sediment concentrations.

Copper availability appears to be a major factor affecting invertebrate tissue residues. While the highest tissue levels (Table 11) occurred at those stations where sediment levels were also highest (stations 0008 and 0012), high tissue residues were also found at those stations where copper levels in the sediments were low (stations 0010 and 0004) (Figure 15). Benthic organisms appeared to accumulate copper from those sediments low in organic matter and in general, tissue levels were higher than sediment levels in areas of sandy sediments. In some cases these areas contributed to higher total tissue concentrations than nearby areas of mainly silty sediments, e.g., station 0010 and 0006.

Luoma (1983) has suggested that availability from the water, principally as the free ion, controls uptake in benthic organisms. Moore *et al.* (1988) have shown that interstitial water in the oxidizing zone can contain much higher levels of copper than interstitial water in the reducing zone. Oxidizing conditions in sediments existed at the 3 cm depth only at station 0004 (Eh; Table 6). The higher oligochaete body burdens at this station may therefore reflect a greater availability of Cu in the interstitial water due to Eh changes in the sediment. The biota-sediment concentration ratio at station 0004 was 17.3 under oxidizing conditions and low sediment Cu concentrations, whereas, at station 0008, where reducing conditions prevailed and the highest sediment copper levels were recorded the ratio was 0.31.

Copper uptake appears, at least in part, to be controlled by availability, though there is some suggestion that organisms can to some measure control uptake as well (Luoma 1983). Availability from the sediments, either through ingestion of sediment or through adsorption from the interstitial water can contribute varying amounts depending on sediment conditions.

Chromium was concentrated to lower levels in tissue than Cu, despite similar sediment concentrations. Organic matter appears to be a major factor affecting availability of Cr as well, and biota-sediment concentration ratios were lower at those stations where organic content (TOC) was high, despite generally higher sediment Cr levels in these areas. Tissue levels could not be related to levels in any of the sediment fractions. While high

levels were consistently present in the organic fraction (F3) at those stations closer to the STP and in Ashbridges Bay (stations 0008 to 0010), levels in tissue varied considerably. Except for stations 0008 and 0005, tissue levels varied inversely with sediment organic content. Total tissue concentrations were generally higher in areas of sandy substrate than in areas of silty substrate. The highest concentration ratio was at station 0004, where substrate was predominantly sand (95%). The results suggest that availability is limited by organic content of the sediments (Table 24).

Mercury levels in tissue varied only slightly among the stations (Table 11) and those organisms inhabiting sediments high in Hg (station 0008) had tissue residues only slightly higher than those inhabiting sediments very low in Hg (station 0004). The tissue-sediment concentration ratios were lower in sediments higher in organic content, indicating that organic matter may be controlling availability from the sediments. Concentration ratios were highest at those stations where sediments were primarily sand with a low silt and hence organic content.

Iron did not vary significantly in organism tissues when considered on a dry weight, gut corrected basis (Figure 15). Levels did vary slightly in the more available fractions, with higher levels present in the F1 and F2 sediment fractions at stations 0008, 0005, 0003 and 0012. Total tissue concentration was highest at station 0008 as were sediment Fe levels. However, outside of Ashbridges Bay, tissue levels could not be related to sediment levels either in bulk sediment or in the various fractions. Iron levels in benthic biota outside of Ashbridges Bay were inversely related to organic matter. The highest biota concentrations outside of Ashbridges Bay were obtained at stations 0002 and 0004, where organic matter and sediment Fe levels were lowest and suggests that availability from the sediments was higher due to the lack of organic matter, or that uptake was principally from the water phase.

Tissue and sediment lead levels were highest in Ashbridges Bay. Outside of the Bay, tissue levels appeared to vary independently from sediment levels and in one case tissue levels were lower in areas of higher contamination (e.g. station 0001) (Figure 15). Concentration ratios varied inversely with sediment TOC suggesting that organic matter limits the availability of lead as well (Table 24).

Zinc levels also showed considerable variation among stations (Table 11; Figure 15), though this variation could not be related to any particular feature of the sediments. The highest tissue levels of zinc were actually found outside of Ashbridges Bay, even though the highest sediment levels were found at station 0008 (Figure 19). *Oligochaetes* at station 0012 accumulated the highest tissue levels (approximately 2 times higher than at station 0008) though sediment levels were nearly 7 times lower than at station 0008. Though sediment levels of zinc were lowest at station 0004, *oligochaetes* accumulated zinc to levels close to those at station 0012 and were the second highest overall. It has been suggested that since zinc is an essential micronutrient, organisms can control uptake at the cellular level (Luoma 1983). However, the distribution pattern suggests that availability from the sediments is a significant factor controlling uptake and this in turn seems to be influenced primarily by sediment organic matter. Concentration ratios of zinc (Table 12) were highest in those sediments that had the highest sand content. The high ratio of 30.9 at station 0004, where sand comprised 95% of the substrate and organic content of the sediments was negligible, indicates that even though low levels of zinc were present in these sediments, it was readily available to benthic organisms either through food, desorption to interstitial water or both. Levels of zinc in the overlying water were low at all stations though the water column cannot be discounted as a source of zinc, and in fact, all metals to benthic organisms.

Arsenic levels in biota were lowest at stations in, and adjacent to, Ashbridges Bay (0008, 0005, 0001) (Table 11; Figure 15) while sediment levels were highest in Ashbridges Bay and at station 0009. The highest tissue residues occurred at stations 0010 and 0011 in areas of low sediment concentration. As with the other metals discussed previously, tissue levels were highest where sediment organic matter was reduced and sediments were primarily sands. Arsenic levels in biota could not be related to redox potential of the sediments though Moore *et al.* 1988 suggest that interstitial water concentrations of As increase under reducing conditions. This does not seem to be apparent in this study, where significant bioaccumulation occurred at station 0004, under apparently oxidizing conditions while lower tissue residues were recorded at station 0005 and 0001 under relatively strong reducing conditions.

Levels of manganese in tissues also appeared to have little relationship with sediment

levels (Figure 15). Moore *et al.* (1988) noted that Mn increases in pore water under reducing conditions, which suggests that if pore water is the main factor governing tissue levels, body burdens should increase in reducing sediments and should be lower in oxidizing sediments. The levels of Mn in oligochaetes shows that no such pattern is evident. Levels were actually highest at station 0004, the only station at which oxidizing conditions would be present. No significant correlations were obtained between tissue residues and any of the geochemical fractions. Increases in Mn in the F1 fraction at station 0002 did not result in higher tissue levels than at station 0007, where levels in these fractions were lower. The highest concentration ratios were at stations 0012 and 0004, both of which were in areas of low sediment concentrations.

Levels of Al and Ni showed similar patterns of accumulation in benthic biota with the highest body burdens at station 0004 where both sediment concentrations and TOC levels were lowest. Sediment organic carbon was inversely related to concentration ratios, suggesting that binding to sediment organic matter reduces the availability of both Al and Ni (Table 24).

Uptake of all metals by benthic organisms seemed to be related only in part to sediment concentrations. While differences in the organic content of the sediment seem to explain differences in uptake, and generally point to an inverse relationship between availability from the sediments and the organic matter content of the sediment, this cannot be determined with any certainty. Uptake from the water column may be significant, though since the water concentrations are low (and represent merely one point in time as opposed to sediments, which are a cumulative record) it has not been possible to determine the importance of the contribution from the water column to the accumulation of metals by benthic organisms.

Levels of PCBs in benthic organisms correlated poorly with sediment levels in July-August. Tissue levels were generally below detection limits, except at stations 0001, 0010, 0006 and 0009 (Table 13), though these stations did not have detectable levels of PCBs in sediments (Table 8). Tissue levels, corrected for dry weight and gut contents show the highest levels of accumulation were at stations 0009 and 0010. Detectable sediment levels were actually obtained only at station 0008 but tissue levels were below detection limits at this station and suggests that no detectable accumulation was occurring from these sediments. The elevated

tissue levels at some stations outside of Ashbridges Bay, despite low sediment levels, indicates that availability from the sediments is high, or, that other sources, such as the water column or suspended sediment, may also be significant sources.

Bioaccumulation of hydrophobic compounds seems to be due primarily to availability from the sediments, which in turn is governed by their solubility and fugacity (the tendency of a compound to leave one compartment and move to another). Literature to date indicates that sorption of these compounds is primarily from the dissolved phase and that sediments act principally as either reservoirs for desorption to the water phase (McElroy *et al.* 1989; Smith *et al.* 1988) or as sinks. Desorption from the sediment solid phases would tend to result in increased concentrations in the interstitial water, increasing the potential for biological uptake. If the sediment-bound PCBs are assumed to be the main source of PCBs to biota, the low tissue levels in Ashbridges Bay, despite higher sediment levels, suggests that desorption from the sediment solid phases does not occur as readily as at those stations outside of Ashbridges Bay and suggests that PCBs in sediments at station 0008 were more firmly bound to sediment components. The high levels of oil and grease, and the history of use of PCBs suggests that these may be the major reservoir of PCBs at station 0008.

A comparison of sediment data from the two surveys (July-August and October) indicates that levels in sediments can vary temporally in response to physical forces disturbing sediments. Poulton (Pers. comm.) has characterized this area as a high energy environment where waves and currents will sort fine-grained particles towards deeper offshore areas. Therefore, the levels in the sediments at any one time would not be indicative of long term conditions. The accumulated body burdens in the areas outside of Ashbridges Bay were likely obtained over an extended period of time and thus may not necessarily be related to conditions that may prevail in the sediments at any one given time.

PAHs were below detection limits in benthic organisms at all stations (Table 14). The relatively high levels of PAHs in the sediments, particularly near the Ashbridges lakefill, do not appear to contribute to elevated body burdens in oligochaetes. The strong correlation of oils and grease with PAH levels suggests that most of the PAHs are bound to oils and grease in the sediments and are not available to benthic organisms.

Like the hydrophobic compounds discussed above, these compounds also tend to be highly bioaccumulable and uptake of PAHs seems to be related primarily to the dissolved phase rather than the solid-bound phase. Since PAHs correlated highly with sediment levels of solvent extractables, these oils and greases may be limiting the availability of these compounds as well.

Tissue levels of chlorinated aromatics were all below detection limits (Table 15) which is consistent with levels in the sediment and overlying water column (Tables 4 and 10).

3.3.2 Sculpins

Analysis of contaminants in sculpin tissue was seriously hampered by the lack of comparable data between stations. This was due to the presence of three different age classes distributed over two different species and a hybrid in the study area. The species *Cottus bairdi* was found mainly in the near-shore areas, while *C. cognatus* was generally found at those stations located along the Eastern Headland. Comparison was further hampered by the absence of sculpins at some of the stations, principally those in soft-sediment areas. Therefore, the data available for interpretation are incomplete and any conclusions must be interpreted with the utmost caution.

Few differences appeared to exist between tissue metal levels and different age classes (of the same species) of sculpins for most of the metals (Table 16). In some cases older individuals appeared to accumulate less than younger individuals, while in other cases older fish had higher tissue levels.

Tissue levels of aluminum and iron in all species of sculpins were approximately an order of magnitude lower than levels in benthic invertebrates. Levels of both metals in sculpin tissue showed an increase with distance from the outfall and levels were generally higher at stations 0002 and 0004, along the Eastern Headland. This was similar in pattern to accumulation of aluminum and iron by benthic invertebrates, where high tissue levels were recorded at stations 0002 and 0004 (for aluminum). Availability from the water column does not appear to be a factor due to low levels in water.

Sculpin tissue levels of mercury were generally as high or slightly higher than levels in

oligochaetes. Mercury levels in sculpins were highest at stations near Ashbridges Bay and decreased to lowest levels at stations 0002 and 0004. However, species differences did appear to exist, with *C. bairdi* appearing to accumulate generally higher tissue levels than specimens of *C. cognatus* caught at the same stations. Some species of sculpins evidently accumulated Hg to higher levels in tissues than did benthic invertebrates, though the mechanism of accumulation is unclear.

Tissue levels of cadmium were approximately an order of magnitude lower than in oligochaetes. Levels were comparable at all stations at which sculpins were obtained and showed few species or age differences. An exception was noted at station 0007, where tissue levels were considerably lower than elsewhere in the study area (Table 16). Levels in sculpin tissues could not be related to sediment levels. Highest sediment levels occurred in Ashbridges Bay while the lowest sediment levels were at station 0004. Sculpin tissue levels were not different between these two extremes and suggest that body burdens are independent of sediment concentrations.

Levels of chromium in tissues varied only slightly among stations and tissue levels in sculpins collected in Ashbridges Bay were similar to levels of those collected outside. Tissue levels were actually highest at station 0003, where the highest water concentrations were recorded.

Tissue levels of copper in *C. cognatus* were slightly higher at those stations in and near Ashbridges Bay (Table 16). Levels in sediment or water did not appear to be related to sculpin tissue levels, with much higher levels in sediment occurring in Ashbridges Bay. Similarly, tissue levels in benthic invertebrates did not appear to be related to sculpin tissue levels.

Sculpin tissue lead levels were highest at stations in Ashbridges Bay and at station 0003 (*C. bairdi* hybrid and *C. cognatus* respectively). Since sediment concentrations were highest at station 0008 and low at station 0003, and water levels were low at all stations neither of these appears related to sculpin tissue levels.

Tissue levels of zinc were slightly higher in Ashbridges Bay than at stations outside, where higher sediment levels were also recorded. Tissue levels in benthic invertebrates showed similar levels at stations 0008 and 0004. Few differences in tissue levels were found between different species or age

classes (Table 16).

In general, tissue levels of metals in sculpins could not be related to any specific source. Tissue levels varied only slightly between stations and were often similar in areas of high and low sediment contamination. Only mercury and arsenic were found to accumulate at some stations to higher levels than in benthic invertebrates. Copper was found at levels higher than in sediments at station 0004, while mercury levels that exceeded sediment levels were recorded at stations 0002 and 0004. As with the benthic invertebrates, higher tissue levels of some metals were found in areas of sediment high in sand and low in organic matter content. The suggestion is that sediments low in organic matter may not be able to bind the metals as effectively as sediments high in organic matter, and as a result, in these areas availability from the sediments may be greater. A similar pattern was observed in the distribution of metals in benthic invertebrate tissues.

In addition to metals, a few of the organochlorine insecticides were also found in sculpin tissues at levels above detection limits (Table 17). These were A-BHC, dieldrin, endosulfan sulphate and pp-DDE. With the exception of a-BHC, levels of all of these in both the water column and the sediments were below detection limits (except sediment in Ashbridges Bay). Tissue levels in benthic invertebrates were also below detection limits so no apparent source is indicated. Studies in the literature indicate that persistent nonpolar organics are principally adsorbed from the water, but that food sources can also be a major contributor to body burdens, especially for those compounds for which depuration rates are very low (e.g. DDT) (McElroy *et al.* 1989). Tissue levels, normalized for lipid content (i.e. assume an organism composed of 100% lipid) did not vary markedly between stations, though slightly higher tissue levels for A-BHC were obtained in Ashbridges Bay. The suggestion is that tissue levels are determined primarily through availability as a result of release from the sediments, which act as the major reservoir for nonpolar organics. The similarity of tissue levels throughout the study area suggests that the available compounds are generally distributed and are not associated with a specific source in the area.

Analysis of tissue levels of chlorinated aromatics showed that only hexachloroethane, 1,2,3 trichlorobenzene, hexachlorobutadiene, and 1,2,3,4 tetrachlorobenzene were found at levels consistently above detection limits (Table 19). Levels varied only

slightly among stations and variation among fish from the same station was often higher. Nonetheless, it does appear that these compounds are generally available to the sculpins, most likely from the water column, since tissue levels in invertebrates as well as sediment levels were below detection limits.

Tissue levels of the trichlorophenols were all below detection limits (Table 20). Levels of pentachlorophenol in tissues were consistently above detection limits. Though variation among individuals at a given station was high, levels outside Ashbridges Bay, and in particular, levels at stations along the Eastern Headland were slightly higher. PCP was found in tissues of all specimens from all stations.

The distribution of PAH compounds in sculpins was very low (Table 18), given that relatively high levels were found in the sediment, particularly at those stations in and near Ashbridges Bay. Phenanthrene, fluoranthene, benzo[a]anthracene and chrysene were detected in sculpins only at station 0003. Benthic invertebrate tissue levels were below detection limits, while sediment levels at station 0003 were lower than stations in and near Ashbridges Bay. Since these results are based on only one specimen they must be interpreted with caution. No other organisms in the study area accumulated detectable levels of PAHs in their tissues.

In many cases, the tissue levels of metals in fish were lower than levels in benthic invertebrates, which suggests that sediments can play a role in increasing the availability of metals to benthic organisms, especially the sediment infauna. The most likely mechanism is through desorption of the metal from the sediments to interstitial water, though ingestion appears to also be a significant route for at least some metals under certain conditions. Studies have shown that levels of contaminants in the interstitial water are usually more similar to sediment concentrations than to water column concentrations (McElroy *et al.* 1989). In addition, desorption from the solid sediment fractions to the interstitial water could provide a more constant supply of contaminants than the water column, which would depend primarily on autochthonous input. Such differences in exposure could readily account for differences in uptake patterns between these two groups of organisms.

Levels of some metals were similar in both sculpin and oligochaete tissues (Figure 19). Arsenic levels in sculpin tissues appear to follow a similar pattern to the distribution of arsenic in sediments, with high levels in Ashbridges Bay and a gradual decrease with increasing distance from the STP discharge (Figure 19a). Invertebrate tissue levels followed a similar pattern but body burdens were much higher at station 0004. The relatively low concentrations of As in these sandy sediments are apparently much more readily available to the benthic infauna. A similar pattern was observed with zinc (Figure 19c) and copper (Figure 19d) and suggest that sediment sources are the main routes of uptake in both organisms. Mercury levels in sculpin tissues were slightly higher than invertebrate tissue levels (Figure 19b). Accumulation of this metal in sculpins may be from both water column and sediment sources (through consumption of contaminated food). The remaining metals were all present in sculpin tissues at much lower levels than in benthic invertebrates and suggests that these levels are most likely due to adsorption from the water, rather than from the sediments. However, the lack of a mechanistic model for metal behaviour in sediments limits the information

3.4 Sediment Bioassays

The results of the acute toxicity bioassay are presented in Table 24. The percent mortality over the ten day period is shown for both mayflies and fathead minnows.

Percent mortality can be compared with a previously determined "safe value" of 20%. Where the results exceed this level, significant mortality has occurred. Mortality in the control must not exceed 10% for the bioassay to be considered valid. The results show that the sediments were not acutely toxic to mayflies at any of the stations over the ten day test period. The highest mortality occurred at station 0010 and the 13% mortality is considered low. Contaminants in sediments did not appear to be acutely toxic to mayflies even at those stations where contaminant levels were high (station 0008). This suggests that these contaminants were not in a biologically available form over the 10 day test period.

The results however, do show that mortality was high among the fathead minnows, particularly at stations 0005, 0006, 0010, 0007, and 0002. Mortality was low at station 0008, where the highest

contaminant concentrations were recorded. The data suggest that after mixing and aeration, release of potentially toxic contaminants from the sediments collected at stations 0005, 0006, 0010, 0007, and 0002 was high, while release from the latter sediments was low. A similar pattern has been noted earlier in this report in relation to organism body burdens. High mortality (100%) was observed at stations 0006, 0010, and 0007. Since data on tissue accumulation levels were not available for these stations, the causes cannot be determined with any certainty. No apparent causes for this high mortality can be ascertained since contaminant concentrations in both sediment and water differed very little from other stations outside of Ashbridges Bay. However, mortality did appear to be lower at those stations where sediment TOC levels were high, suggesting that release of contaminants may have been a factor. The ability of sediment organic carbon to effectively reduce the availability of sediment-bound contaminants has been noted previously.

Accumulation of metals by mayflies showed large increases in body burdens of Cd, Cr, Cu, Pb, and Hg at station 0008 as opposed to levels in the control animals (Table 21).

Fatheads accumulated higher tissue levels of Cu, Zn and Hg than mayflies at all stations (Table 21). It appears from these increased body burdens that release of these metals to the water is greater than for the other metals resulting in greater uptake by water column organisms. Tissue levels were highest at stations 0002 and 0001, where 67% and 40% mortality occurred. This suggests that tissue levels might have been higher still at those stations where 100% mortality was observed, and it is possible that these metals may have contributed to the acute toxicity of these sediments to fathead minnows through a greater release to the water column. However, tissue levels, at their highest, were less than 2 times those in the control fish and Hg levels in the control fish were considerably higher than sculpin tissue levels as discussed in the previous section. Tissue levels in mayflies at stations 0006, 0010 and 0007 were only slightly higher than at the other stations and suggest that these metals were not released in sufficient quantity to result in significant body burdens to mayflies.

No significant accumulations of organics was noted in either the mayflies or the minnows over the ten day test period (Tables 22 and 23). A slight increase in 1,3,5 Trichlorobenzene was noted in both mayflies and minnows at station 0012, with higher levels in the mayflies (Table 23). This would

be consistent with sediment sources supplying interstitial water with higher concentrations than water column.

In light of the slight increase in metal body burdens in mayflies at the stations at which 100% fathead minnow mortality was observed, the causes for the mortality remain unclear. While metal toxicity may have caused the high mortality in minnows, this seems unlikely to be solely responsible and suggests that other, unmeasured substances may also be a factor. The lack of consistency between the mayfly and the minnow responses supports this conclusion.

3.5 Benthic Community Analysis

The results of the benthic analysis are presented in Tables 28 and 29. The species composition suggests that most of the nearshore areas can be characterized as eutrophic, while the offshore areas appear to be eutrophic to mesotrophic.

In Ashbridges Bay, station 0008 yielded a fauna typical of organically polluted areas (Brinkhurst 1970). Only the oligochaetes were present in this area and the species of *Limnodrilus* formed the entire fauna (Table 29). The organic content of the sediments was extremely high, with most of the substrate comprised of silt. In similarly polluted areas in other parts of the Great Lakes, for example the Kam River (Jaagumagi 1987) organically polluted areas yielded densities of between 400,000 to 500,000 worms per m². By comparison not only with these areas but also with other parts of the Toronto Waterfront (Jaagumagi 1988) the density of worms here (6,704 worms/m²) was remarkably low. The high levels of contaminants in these sediments may be significant since some metal concentrations, such as copper, chromium, cadmium and zinc were many times higher than the Open Water Disposal Guidelines set by MOE (Persaud and Wilkins 1976). Copper, in particular, was close to the levels Wiederholm *et al.* (1987) found were toxic to oligochaetes in their experiments. Therefore, it seems reasonable to conclude that contamination of the sediments by a variety of both metals and organic pollutants has had some effect on the benthic fauna.

Station 0005 was in marked contrast to station 0008. Though sediment data indicate that the substrate was mainly sand with only a low percentage of silt (90% sand: 6% silt), the

sediments in this area can be highly variable spatially (A. Hayton, Pers.comm.). Thus, the sediment sample may not be entirely representative of the area sampled. Density of benthic organisms was among the highest of any of the stations surveyed. The fauna, like that at station 0008, was comprised entirely of fine sediment feeders of which the largest group was the oligochaetes (99.8%). These were represented almost exclusively by *Limnodrilus* spp with only a small percentage of *Quistadrilus multisetosus*, a species common in sandier substrate (Brinkhurst 1986). While sediment contaminant levels were lower than at station 0008, in many cases these still exceeded MOE Open Water Disposal Guidelines, though they were more comparable with other areas outside the Bay. The high density and biomass attests to an impact from organic matter though no definite impact could be attributed to sediment contaminant levels.

Located in an area of similar sediment type and organic content, station 0001 had the highest density of organisms of any station (Table 28). As at station 0005, the fauna was comprised entirely of sediment fine particle feeders, which consisted almost entirely of *Limnodrilus hoffmeisteri* (Table 29). Though both stations 0005 and 0001 appear to be in erosional areas, there is evidently a high variability in levels of organic matter. Levels of contaminants were lower still at this station relative to station 0005, despite the higher organic content of the sediments and this may also have been a factor contributing to the higher density of organisms.

Station 0003 was located near the Main STP diffuser in an area of higher turbidity. Organic content of the sediments was lower at this station and this change was paralleled by a reduction in benthic invertebrate density, though species composition remained virtually unchanged. *Limnodrilus hoffmeisteri* was the major component of the fauna, which itself was comprised entirely of fine sediment feeders. Contaminant levels in the sediments were similar to the two preceding stations and would likely have had a small influence on the reduced density of organisms.

Station 0012, also located in deeper water, but off the entrance to Ashbridges Bay, appears to be receiving some washout from the Bay in addition to discharge from the STP outfall. Both sediment organic carbon levels and contaminant levels were higher than at some of the other stations around the headland (Table 6). Benthic density and diversity were both low in comparison to the other

deep water stations (0011 and 0009) and in comparison to stations discussed above (Table 29). Though the sediment in-fauna still formed the major part of the community, a large reduction in the oligochaete population occurred despite an increase in the sediment organic matter content. The higher levels of contaminants, mainly the metals, may have had some effect on density. Diversity, in comparison to the other deep water stations, was also lower. Sediment bioassays also indicated a low level of toxicity associated with these sediments.

Station 0006 though located at the base of the eastern headland about 300 m offshore, was still close to the end of the STP discharge. Density of organisms was lower than the previous stations discussed and may be due to reduced organic matter in the sediments. While the oligochaetes still comprised the largest faunal group and diversity was limited, density was comparable with stations further off-shore (stations 0002 and 0009).

Substrate at station 0010 indicated this station was in an erosional area and organic carbon levels were relatively low (Tables 5 and 6). Sand formed 81% of the substrate, though *Limnodrilus* dominated the benthic fauna which was comprised entirely of sediment feeders. Deposition and transport of organic matter in this area seems to be the main factor affecting the benthic community, for while sand content was high, only those members of the benthic community that are known to be tolerant of organic enrichment were present. These species are often also the most tolerant of elevated contaminant concentrations (Chapman *et al.* 1982a, b). No species typical of sandy substrates (Johnson *et al.* 1987) were noted, which suggests that contaminant levels, in conjunction with sediment characteristics, may have been a factor. Sediment bioassay results show the highest mayfly mortality at this station over a period of ten days. While the mortality during these tests was relatively low, over a prolonged period of exposure some effects on benthic species, particularly the more sensitive, could be expected and may account for the low diversity.

Though similar in both depth and organic content, station 0011 differed considerably in the make-up of the benthic community. While *Limnodrilus hoffmeisteri* was still the most common organism, the presence of other oligochaete species such as *Potamothrix moldaviensis*, *P. vejovskyi*, and *Pristinella jenkiniae* indicate a more mesotrophic character to this community (Table 29). Since depth

and temperature appeared to be similar to station 0012, the differences between these two stations are therefore most likely due to differences in the organic and contaminant levels of the sediments. Though levels of most metals were higher than at station 0010, these do not seem to be as available to benthic organisms since both diversity of organisms was higher, and mortality in the bioassays was lower.

Located approximately 500 m south of station 0010, station 0007 was very similar in species composition. While silt content was higher (47%) the organic content had changed little and this seems to have defined the type of community here as well. *Limnodrilus* spp. predominated (99.8 % of the fauna) and the entire community consisted of sediment feeders. Like station 0010, mortality during the bioassays was higher at this station, and though contaminant levels were similar to levels at station 0011, these may have been more readily available. As at station 0010, the main effect appears to be a reduction in diversity while density of the more tolerant species has remained high.

Located in deeper water, but still close to the headland, station 0002 and also station 0004 (close to the southern tip of the headland) were in erosional areas of lower organic content than any of the previous stations. Sand formed most of the substrate, especially at station 0004, which also had the lowest organic content of any of the stations (Table 6). Density and biomass of organisms was correspondingly low with the lowest density recorded at station 0004. Substrate type at both these stations, as well as at station 0006 and 0010, suggests the erosion of materials from the headland, and their deposition temporarily in these areas. Contaminant levels at these two stations were low. Only station 0002 had a fauna more typical of sandy areas as denoted by the presence of the naids and the oligochaete *Spirosperma ferox* (Brinkhurst 1986). Despite the low organic content at station 0004, the fauna was typical of more organic areas closer to shore, though rather severely reduced in density.

Station 0009, located in deeper water, shows primarily the effects of colder water temperatures. The presence of such deep water forms as *Pontoporeia hoyi*, whose distribution appears to be affected primarily by temperature and little, if at all, by organic content (Johnson *et al.* 1987), and *Monodiamesa depectinata* which has similar preferences (Saether 1975), indicated that the organic levels, though similar to levels near the Ashbridges Lakefill, have only a moderate effect on

the fauna.

In summary, the nearshore areas surveyed yielded a fauna typical of organically enriched, eutrophic conditions. This appeared to be alleviated only by depth and temperature, since even in those areas where more mesotrophic components of the fauna were evident, organic content was high and the majority of the fauna was typically eutrophic. Evidently, deposition of organic matter in these deeper areas was a major factor. As previous studies have shown (Jaagumagi, 1988) areas further offshore do not exhibit the same eutrophic characteristics, even though water depth and hence temperature may be similar. Ashbridges Bay itself is not only polluted organically but the sediments are contaminated as well. This apparently acts to limit the density of the rather restricted, eutrophic fauna of the Bay, which under less contaminated conditions could be expected to be much higher. It also appears that contaminated sediments affect the benthic community outside of Ashbridges Bay, particularly around the STP outfall. Diversity was particularly low in areas where organic content was lower and suggests that, as already noted in other sections of this report, contaminant effects and availability are influenced by sediment organic matter. Accumulation of contaminants and toxicity appear to be heightened where sediment TOC was low, suggesting that sediment organic matter has a strong moderating influence on both.

Biomass

Biomass changes were mainly the result of increased density of organisms, which itself was primarily due to organic levels in the sediments.

While the average weight of individual oligochaetes was higher at station 0008 in comparison to station 0005 and 0001 (Table 28), the latter two stations had a much higher proportion of young individuals (Table 29). The indications are, that despite the increase in the organic content at station 0008, the population there is not reproducing as fast as those at stations 0005 and 0001. This may, as noted in the preceding section, be a result of the high contaminant levels in the Bay which could have long-term effects on the population, either on the young or on the reproductive ability of the adults.

Outside of the Bay a number of trends in biomass are evident. Stations located in deeper and hence colder waters (stations 0002, 0004, 0012, 0011, 0009) all had lower biomass than stations in

shallower water (Table 28). The deeper water stations compared well with biomass values recorded for deeper offshore areas of Lake Ontario (Cook & Johnson 1974; Kinney 1972). Shallower areas, particularly in areas of organic enrichment, had low biomass in relation to the density of organisms, and in nearly all cases this was due to the high proportion of young individuals. This, though dependent on organic content, is primarily an effect of the warmer water temperatures which occur at shallower depths.

4. DISCUSSION

The result of this study clearly show that the discharge of contaminants from a number of sources has affected the quality of both the water and the sediments in the vicinity of Ashbridges Bay. The principal sources are the Main STP sewage treatment plant which discharges treated waste water through its diffuser pipe located approximately 1 km into Lake Ontario (as well as through the seawall gates located along the shore, west of the Coatsworth Cut), and the storm sewer and combined sewer discharges located at the head of Ashbridges Bay. Additional sources are the lakefill structures that, through erosion of fill material over the years, have contributed unquantified levels of contaminants to the sediments.

The area of greatest contamination appears to be Ashbridges Bay. Sediments in the Bay had accumulated high levels of heavy metals, of which copper, chromium, mercury and lead exceeded the Severe Effect Levels of the proposed Provincial Sediment Quality Guidelines. The enclosed nature of the Bay, which limits lakeward movement of material, and the combined sewer overflows that discharge to the Bay are the major contributors to accumulation of contaminants in the sediments. The STP appears to have little if any influence on the Bay except under severe weather effects, at which time the plume may be driven shoreward and into the Bay.

Boyd (1988) and Poulton and Beak (1989) have both noted changes in the surface water quality associated with treated water discharged from the Main STP. The changes in bottom water quality observed during this study were similar to surface water quality changes and are mainly associated with increases in levels of suspended solids, conductivity, turbidity and some of the heavy metals.

Poulton and Beak (1989) noted that the effects from the plume were principally confined to a semi-circular area bounded by the Ashbridges lakefill on the east and the Eastern Headland on the west. This is roughly the area occupied by all the stations located outside of Ashbridges Bay, with the exception of stations 0002, 0009 and 0004.

The bottom water survey component indicates that outside of Ashbridges Bay, the greatest increases in the parameters noted above occurred at station 0003 and secondarily at stations 0005 and 0001. All three stations lay within the area of the plume and were located close to the Main STP diffuser.

Sediment metal concentrations were closely tied to sediment organic matter content, and the highest levels of contamination were noted in Ashbridges Bay and along the west side of the Ashbridges Lakefill. The major sources in Ashbridges Bay appear to be the storm sewers that discharge into the Bay. In contrast, three sources of contaminants appear to influence those stations along the Ashbridges Lakefill and these are outflow from Ashbridges Bay, the STP effluent plume, and erosion from the lakefill itself. Those stations within the effluent plume are also affected by these sources. As distance from the shore increases the situation becomes more complex, for in addition to the sources already identified above, contaminated sediments from the near-shore areas can be resuspended and at least temporarily deposited in these areas.

The unstable nature of the sediments in the near-shore areas sampled in this survey suggest that sediment concentrations of contaminants are likely to change significantly over time, primarily as a result of seasonal climatic changes (i.e. resuspension of sediment matter due to wave action) with the net movement being to the deeper areas of the lake.

Geochemical fractionation of the sediments indicates that certain metals, such as Cd, Cr, Cu, Pb and Zn were more closely associated with the less tightly bound fractions in the vicinity of the STP and Ashbridges Bay, and therefore at least potentially more available to aquatic organisms. These same metals were found in the more resistant F4 and Residual fractions at the open lake stations (stations 0011, 0007, 0002, and 0009). If metals do in fact move into the more resistant fractions over time as noted by Andrews (1988) for zinc, then the pattern of deposition suggests that the larger amount in the F1 to F3 fractions in the nearshore areas has been

deposited more recently than areas further into the lake. The area of increased deposition in the F1 to F3 fractions appears to coincide with the general area of effect from the discharge plume as determined by Poulton and Beak (1989). The remaining metals were held primarily in the F4 and Residual fractions.

Significant correlations were obtained for some of the metals between the various geochemical fractions (Table 25). For example Zn was highly correlated between the F2 and F3 fractions and also the F3 and F4 fractions. These correlations may describe the most likely sorption - desorption pathways for metals in the sediments. Studies by Andrews (1988) and Evans *et al.* (1988) have suggested that as sediments age there is a net movement of metals from the more easily exchangeable fractions to the more tightly held fractions, and these statistical relationships may be describing this movement. Tessier *et al.* (1984) found similar results with metals and benthic organisms.

Tissue levels of contaminants in benthic invertebrates and bottom-dwelling fish could not be related to levels in the water column or to either bulk sediment levels (all contaminants) or levels in the geochemical fractions (metals) (bulk sediment metal levels and invertebrate tissue levels for a number of metals (dry weight corrected for gut contents) are shown graphically in Figure 15). In part this is due to the fact that the mechanisms of contaminant uptake by biota in natural systems are not yet fully understood. The analysis of fish tissues in relation to sediment contamination presented additional difficulties. Bottom feeding fish can accumulate contaminants from two different media. They can acquire contaminants from the water column through sorption onto external body surfaces, and they can also acquire contaminants through the ingestion of contaminated food items. It is at present difficult to differentiate the body burdens acquired from the sediment from the amount acquired from the water. Therefore, while fish provide an excellent means of assessing the biological availability of contaminants in a waterbody, they are unable to provide much insight into the availability of contaminants from specific sources such as the sediments. The use of sediment in-fauna appears to be a more appropriate means of assessing contaminant availability and uptake from sediment since these organisms are for the most part relatively sessile. Their virtually continuous exposure to sediment contaminants through

ingestion of the solid phases as well as through surface adsorption from the interstitial water suggests that the contribution of contaminants from the dissolved phase in the water column would be minimal.

Analysis of tissue residues was also hampered by the physical characteristics of the study area. The high energy environment that characterizes the near-shore zone of this area of Lake Ontario means that sediments deposited in this area are subject to considerable resuspension and deposition of fine-particulate matter due to wave, and to a lesser extent, current, action. Therefore, changes in sediment contaminant concentrations can occur both temporally and spatially as a result of purely physical processes. This presents difficulties in relating sediment concentration with concentrations in organism tissues. The latter would represent concentrations accumulated over the lifetime of the individual, while sediment concentrations would be accumulated over an unknown time period, which may vary from hours to months or years. Sediment resuspension and movement could also heighten the availability from the sediments of some contaminants, resulting in an increase in tissue residues in areas of low sediment concentration.

The pronounced effect on the fathead minnow during the bioassay experiment also suggests that resuspension of contaminated material is a significant factor affecting organism tissue residues. The higher tissue concentrations in benthic invertebrates at stations located in the deeper offshore area, may be related to movement of contaminated sediment from nearshore areas.

Sediments in some areas outside of Ashbridges Bay were apparently highly toxic to minnows though no apparent toxicity was apparent in the mayfly response. Toxicity and accumulation of contaminants appeared greatest in those areas lower in sediment organic carbon and again suggest a strong mitigating potential of organic matter. The most pronounced effects appear to occur where sediment TOC was lower, despite similar sediment contaminant levels.

The differences in the responses between the mayflies and the fathead minnows emphasize the importance of testing several aquatic organisms from different ecological niches. Due to habitat or metabolic differences in species, as well as differences in modes of release to the various aquatic compartments, bioavailability and/or uptake

of contaminants can vary considerably between species. The acute lethality endpoint measured in this experiment showed that the water-column organism was affected to a much greater degree than the sediment-dwelling organism, suggesting that there was significant contaminant release to the water. Such an effect would have been missed if the experiment had been restricted to sediment-dwelling organisms. The sediment bioassay however, did not provide any indication of the possible long-term effects on the aquatic biota such as growth inhibition, respiratory changes and reproductive impairment, which could only have been assessed using chronic toxicity tests. That sediments were acutely toxic to the fathead minnows however, suggests that contaminant release from the sediments to the water column may occur in the field, especially in light of the dynamic nature of nearshore environment.

Benthic populations in the study area appeared to fluctuate in response to sediment organic carbon, though in a rather unexpected way. Areas lower in sediment TOC, though of similarly high contaminant levels as areas of high sediment TOC, yielded faunas reduced in diversity of organisms. These areas in particular had as high, or higher, densities of the oligochaete species that are commonly associated with organically polluted conditions. However, recent studies (Chapman *et al.* 1982a,b) have shown that these species are often the more tolerant of chemical contaminants as well. Therefore, though diversity would be expected to be higher in areas lower in organic content, this was not found to be the case. As noted previously in this report, the presence of organic matter appears to mitigate the effects of contaminants in the sediments on aquatic organisms and may account for the higher density and diversity in organically enriched areas, despite the higher contaminant concentrations found in these sediments. None of the areas studied showed a clear indication of effects of chemical contaminants on the benthic fauna. Responses at the community level are a combination of both the natural environmental factors (i.e., substrate type, depth) and introduced factors (organic and inorganic contaminants, organic matter and physical alterations) and it is extremely difficult to isolate the effects of changes in one phase (e.g. sediment contaminant concentrations) except where such changes have had a pronounced effect.

As is apparent from the results of this survey, the ability of such sampling programs to demonstrate direct cause-effect relationships

between sediment contamination and biological effects is limited. In most cases effects of sediment contamination on aquatic biota can only be inferred from the data. In large measure, this is due to the lack of suitable mechanistic explanations for movement of these contaminants in the sediment as well as their action on biological systems.

An additional difficulty encountered in this survey was the multiplicity of contaminant sources, which precluded the linking of specific contaminants in the sediments or biota with a specific source. Again, only inferences can be drawn, based on knowledge of the sources. Since no known method exists for definitively separating the effects from the various sources of contaminants (though tracing the movement of contaminants through the introduction of labelled contaminants could provide greater insight), this is a problem common to all such studies.

5. CONCLUSIONS

Based on the results of the study, the following conclusions may be drawn.

1. Metals, phosphorus and suspended solids were detected at greatest concentrations in bottom waters at the Main STP diffuser. Conductivity was highest in Ashbridges Bay and was related to storm sewer discharges into the bay.
2. Sediment metal concentrations were highest in Ashbridges Bay and copper, chromium, mercury and lead exceeded the Severe Effect Level of the proposed Provincial Sediment Quality Guidelines. High concentrations were also evident in nearshore areas outside of Ashbridges Bay. Metals appear to be accumulating in areas of organic enrichment.
3. Geochemical studies indicate that accumulation of metals in the nearshore areas is mainly into the organic/sulphide-bound fraction, while in offshore areas metal accumulation appears to be mainly into the Fe/Mn hydroxide fraction.
4. PCBs and PAH were detected in sediments at high concentrations in Ashbridges Bay and adjacent nearshore areas, but could not be linked to a specific source. A number of sources, including urban runoff, are implicated

5. There was no relationship between concentrations of PCBs and metals in the tissues of benthic organisms and concentrations in the sediment. Tissue residues were highest in organisms from sediments low in organic matter, suggesting that organic matter acts to control metal and PCB availability to benthic organisms.
6. Despite high sediment concentrations, PAHs were not detected in invertebrate tissues. These do not appear to be available from the sediments.
7. Sculpin tissue residues of metals or organic compounds could not be related to sediment concentrations. Tissue residues most likely result from a combination of sediment and water column sources.
8. Sediment bioassays yielded high mortality among fathead minnows at those stations where sediment contaminant concentrations were relatively high, but organic matter content was low. Mortality was not significant at those stations where sediment concentrations and organic matter content were both high.
9. Sediment characteristics, particularly organic enrichment, had the greatest influence on benthic invertebrate community structure. A toxic effect due to elevated levels of contaminants on the already impacted benthic communities could only be determined in Ashbridges Bay.

6. RECOMMENDATIONS

The only practical action that can be taken to reduce contaminant levels in sediments is control of all sources contributing to the contamination of the sediments. Effective controls on point source discharges could eliminate most of the contaminants originating from the STP and the sewer outfalls. Effective quality controls on materials used in the lakefills would also minimize contaminant contributions from these sources. Only when effective control of all sources has been achieved, should additional remedial action be considered.

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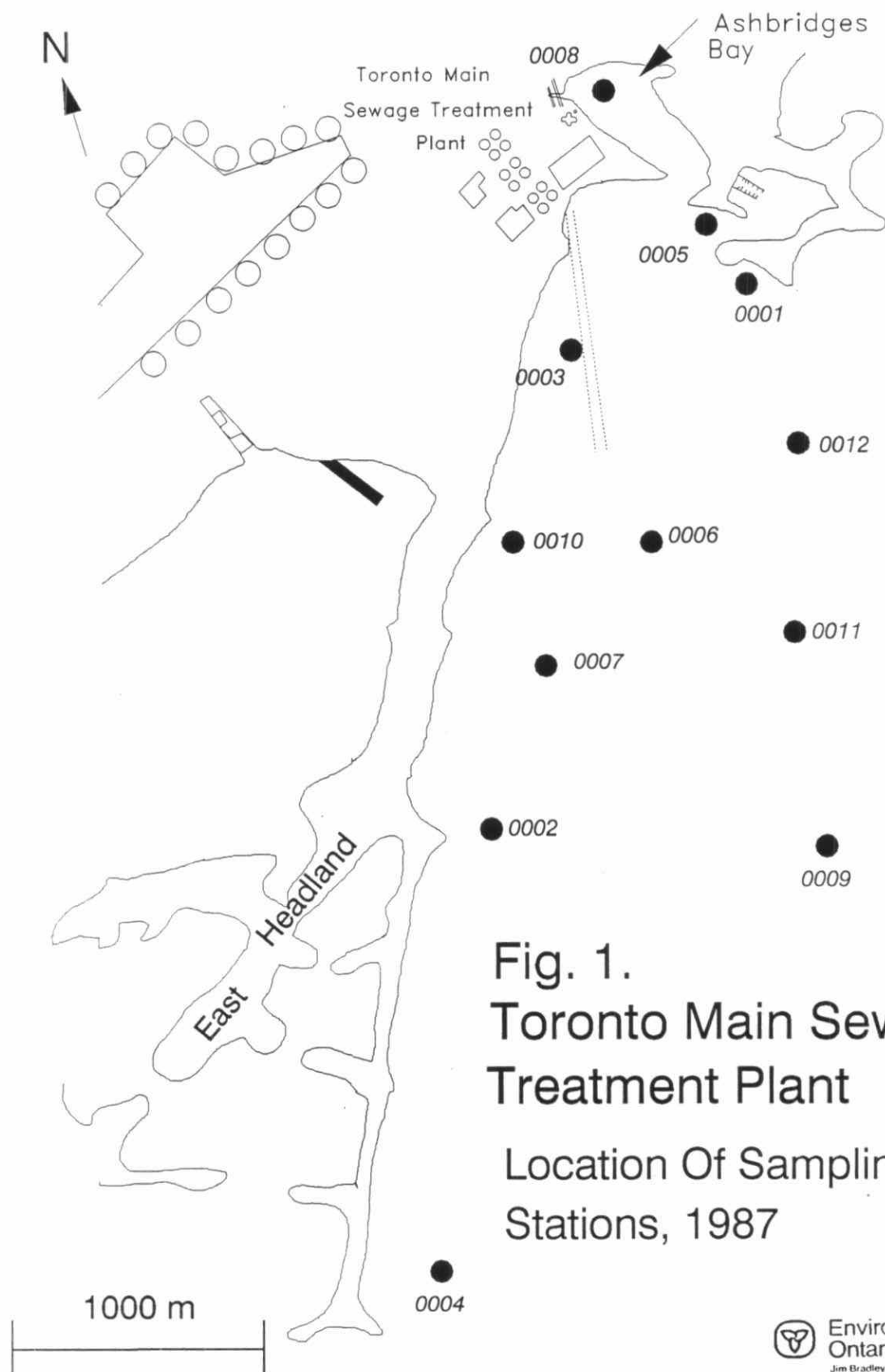
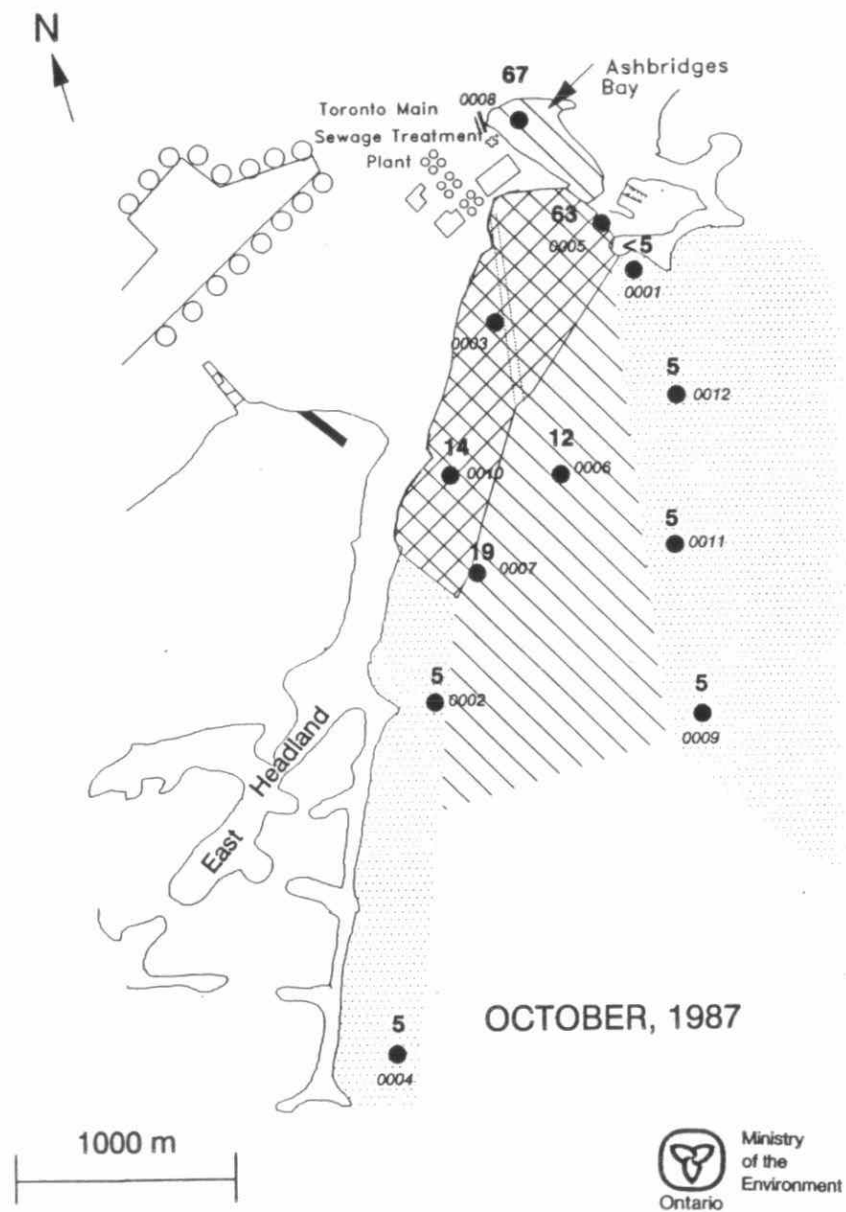
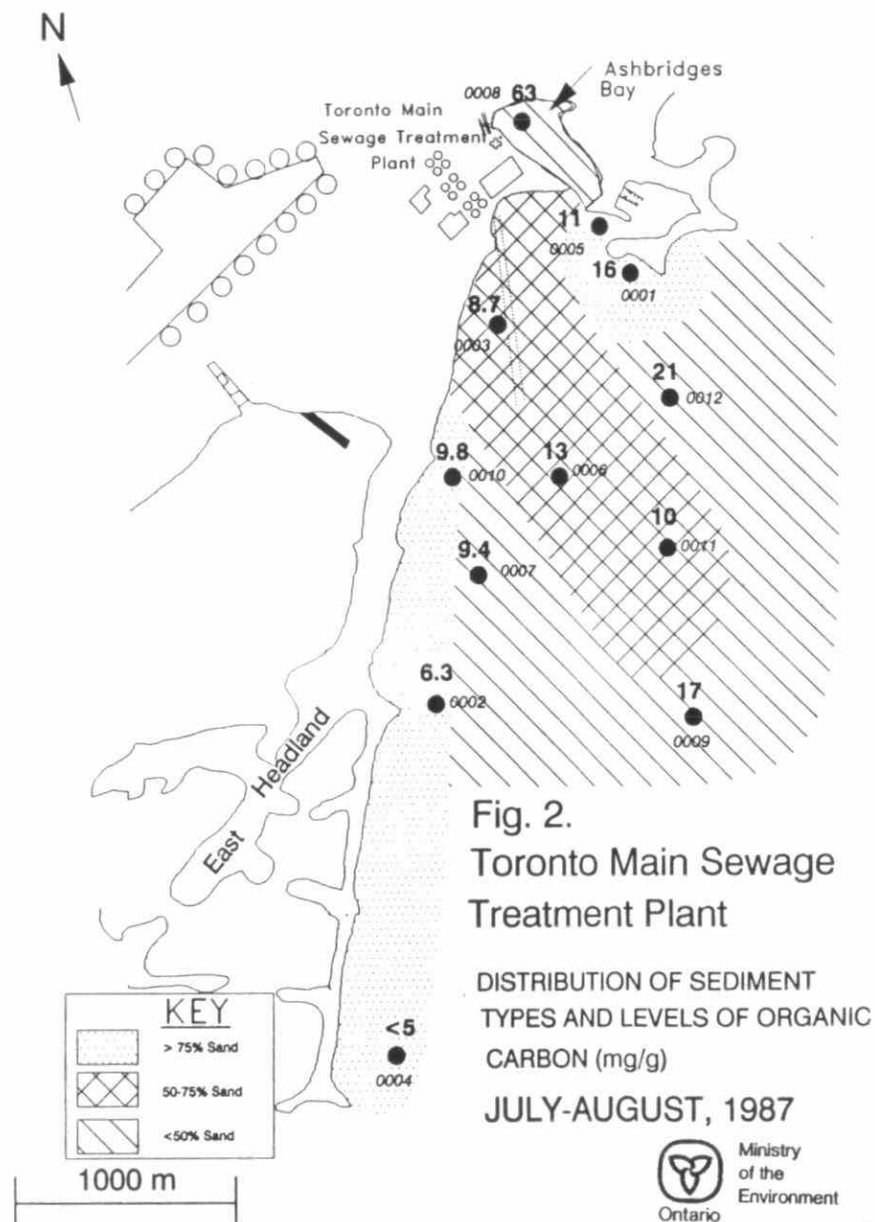
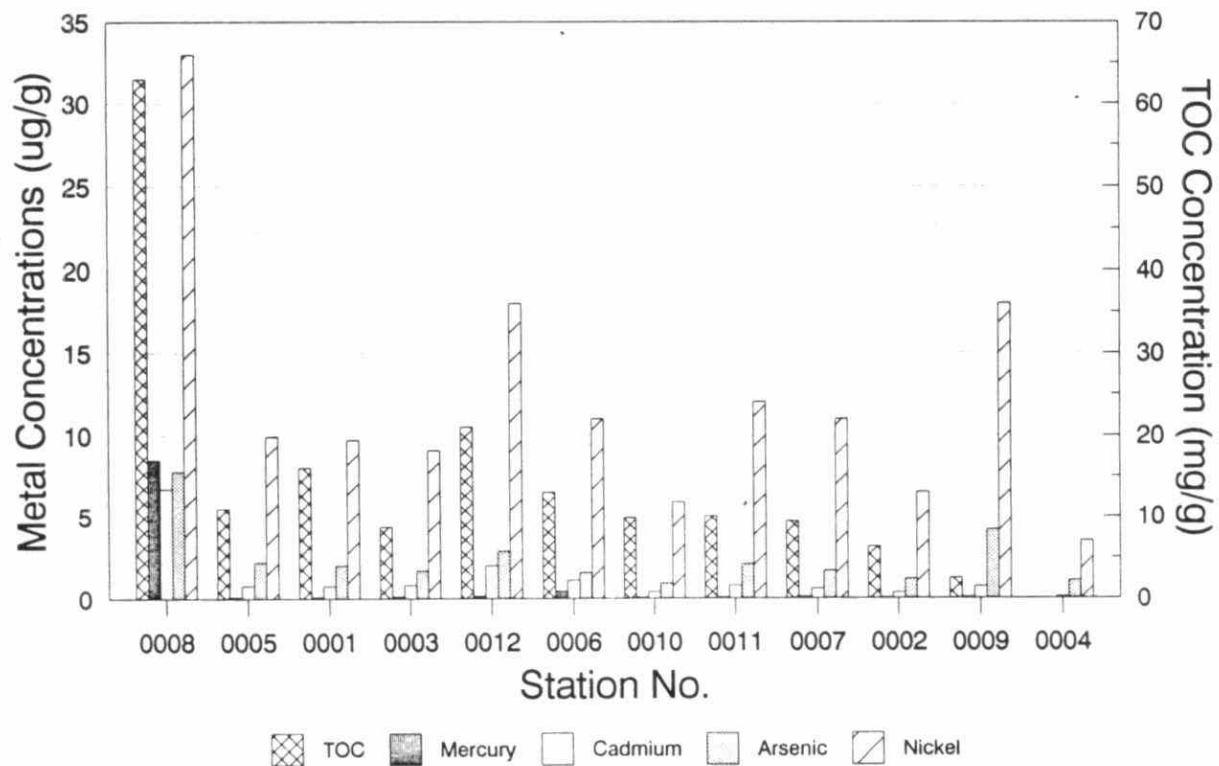
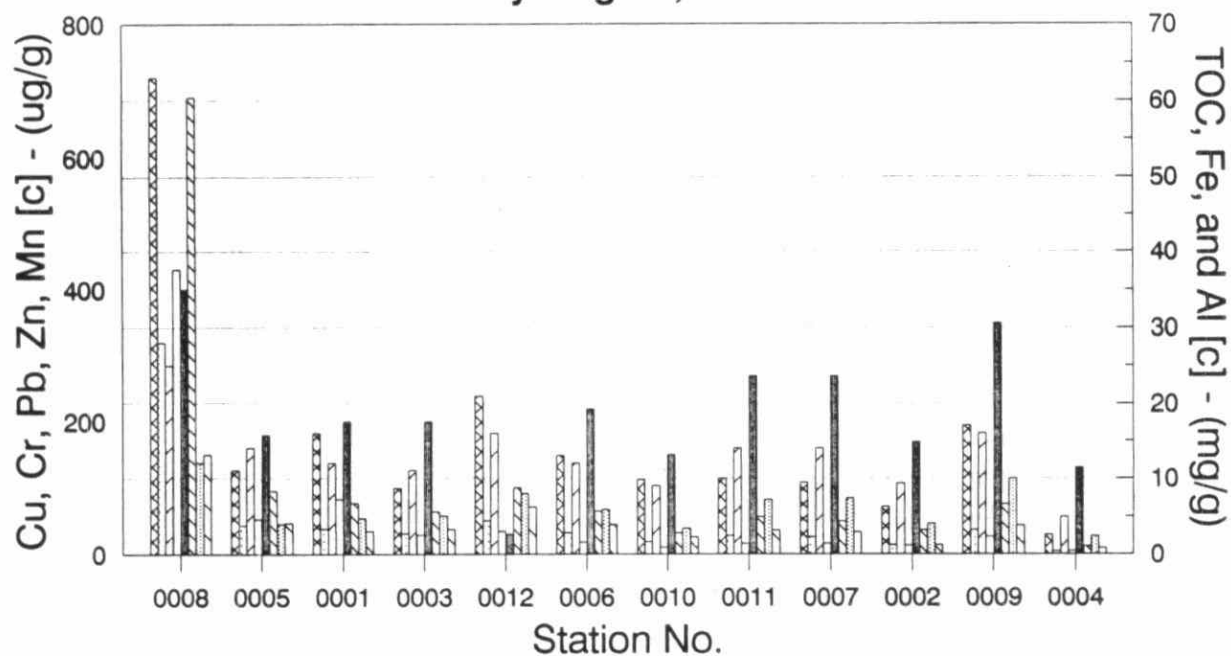


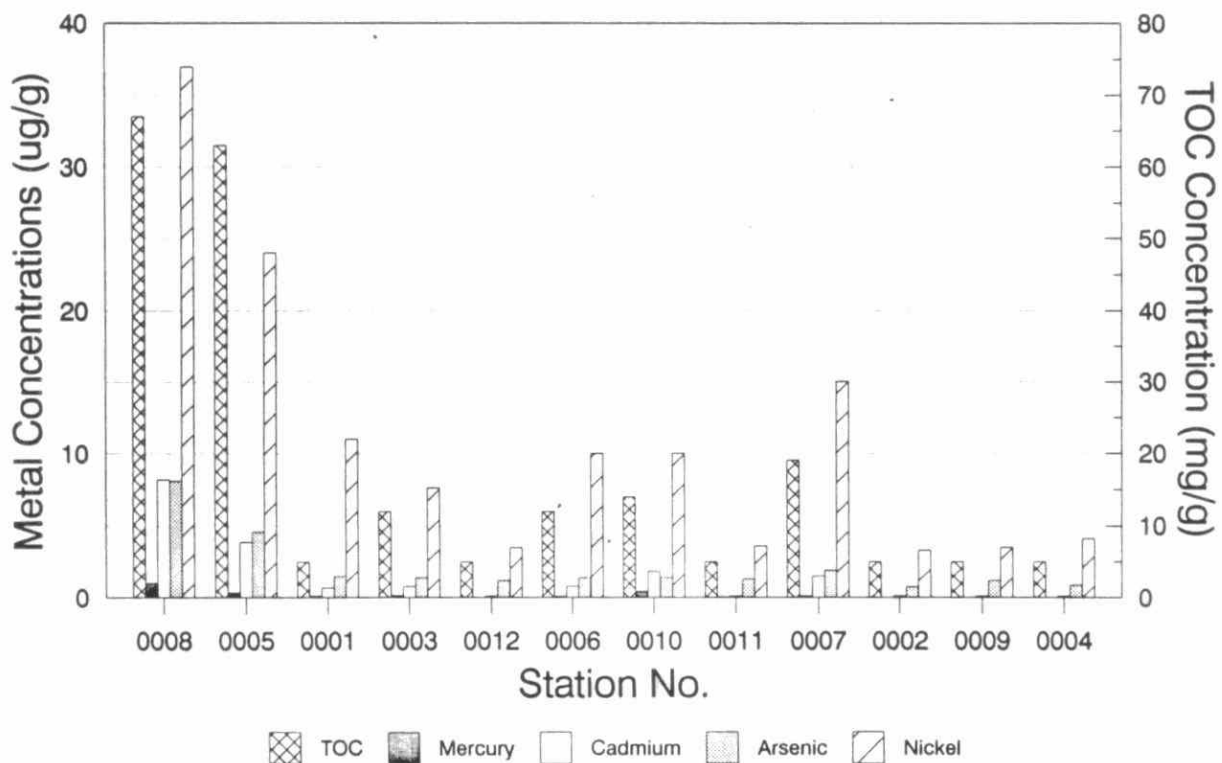
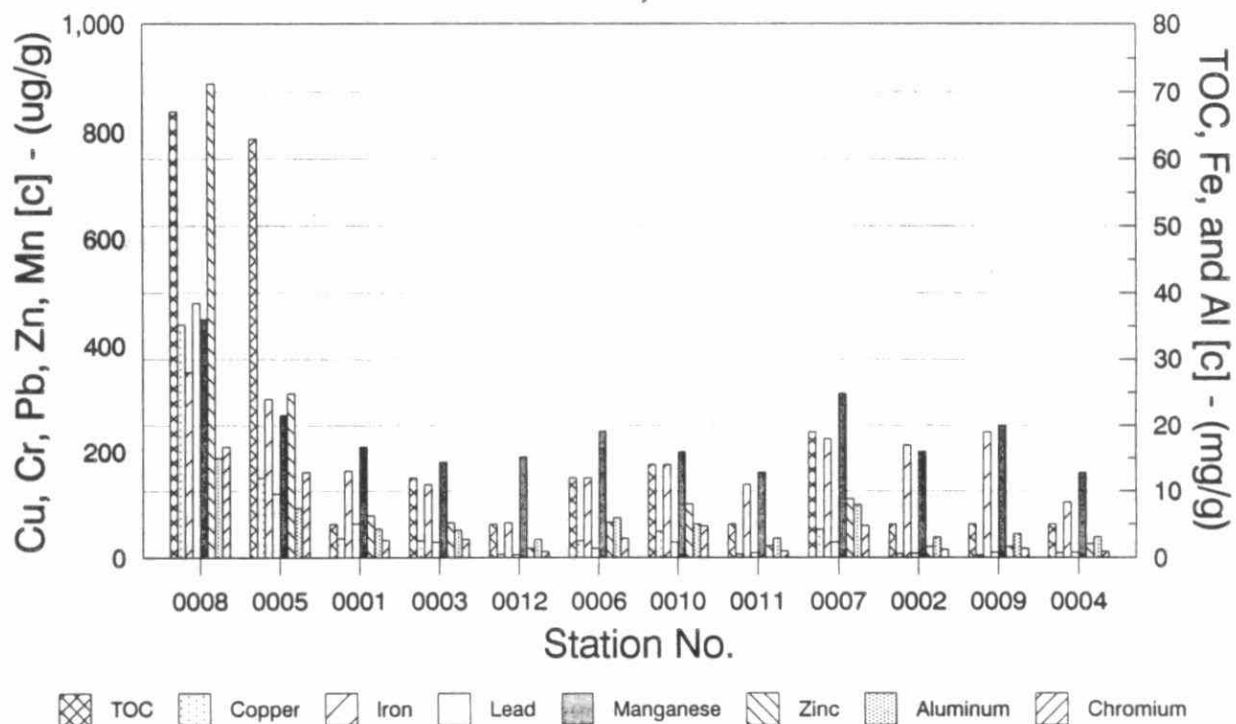
Fig. 1.
 Toronto Main Sewage
 Treatment Plant
 Location Of Sampling
 Stations, 1987



**Fig. 3. Sediment Metal and TOC Concentrations
Toronto Main STP,
July-August, 1987**



**Fig. 4. Sediment Metal and TOC Concentrations
Toronto Main STP,
October, 1987**



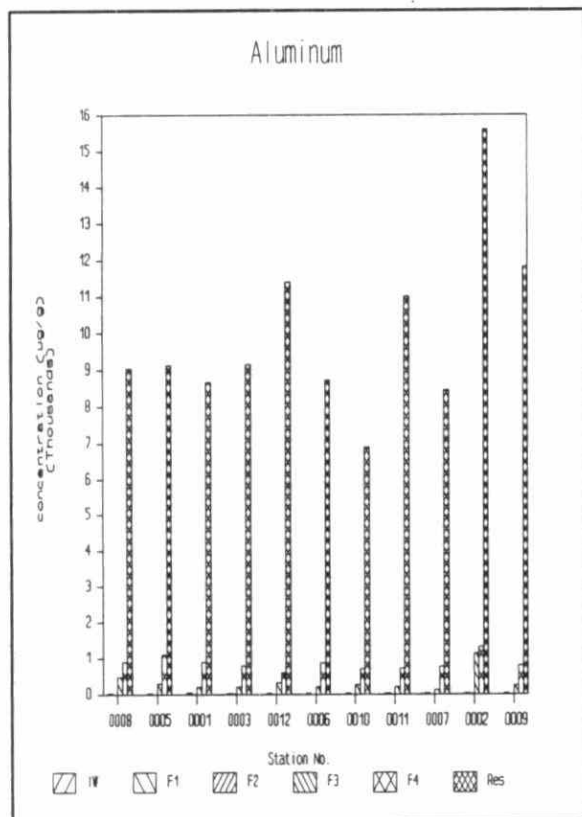


Figure 5: Geochemical Distribution of Aluminum in Sediment (wet weight).

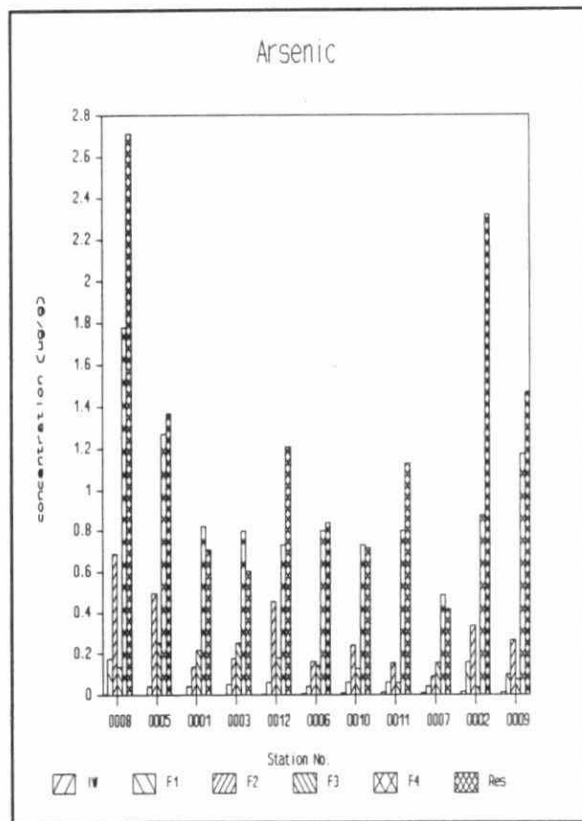


Figure 6: Geochemical Distribution of Arsenic in Sediment (wet weight).

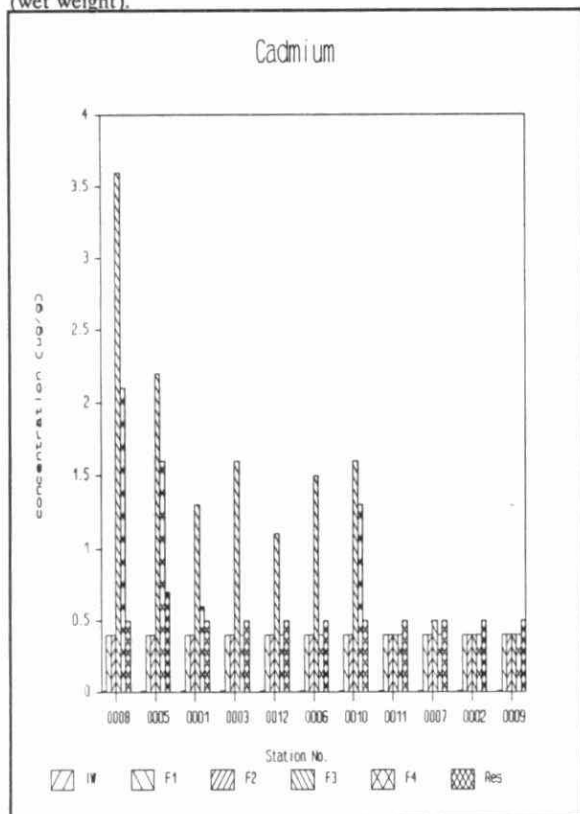


Figure 7: Geochemical Distribution of Cadmium in Sediment (wet weight).

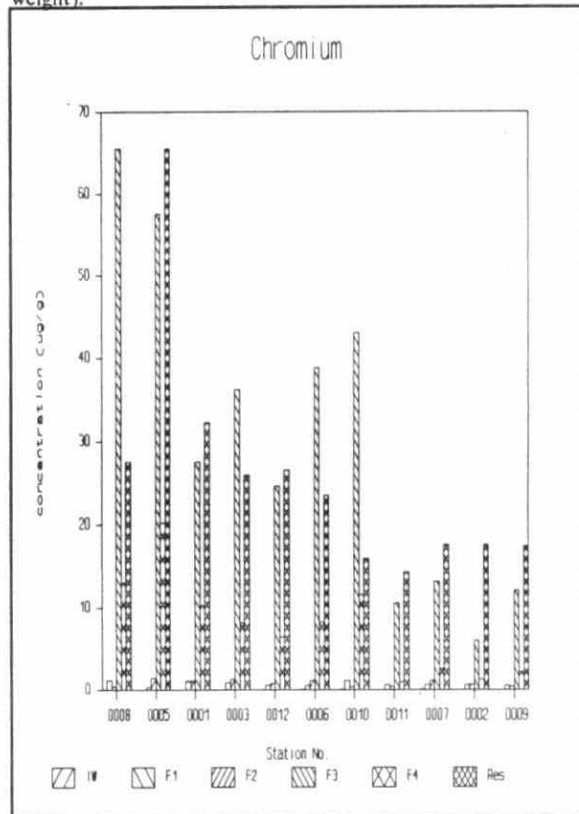


Figure 8: Geochemical Distribution of Chromium in Sediment (wet weight).

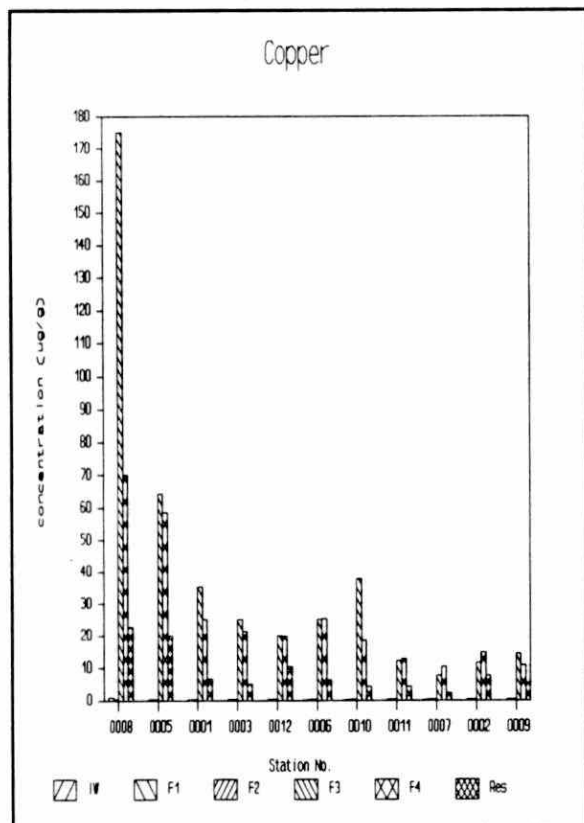


Figure 9: Geochemical Distribution of Copper in Sediment (wet weight).

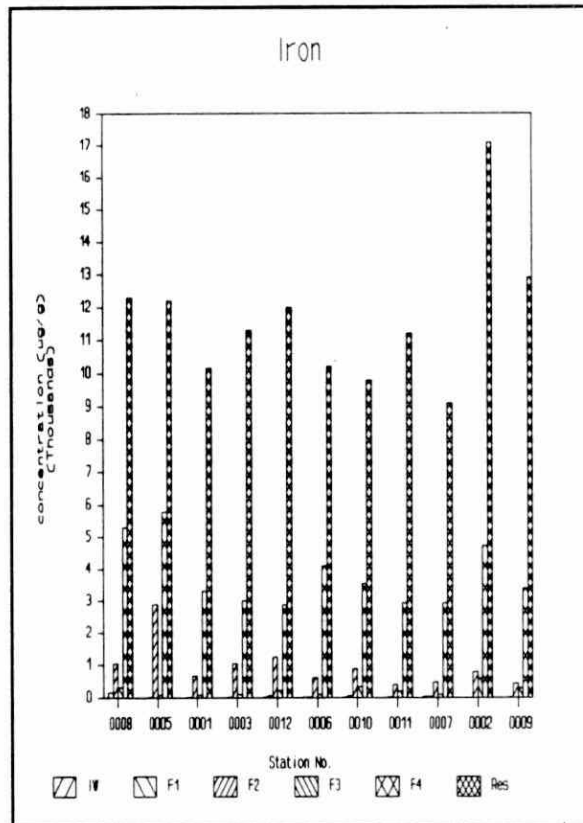


Figure 10: Geochemical Distribution of Iron in Sediment (wet weight).

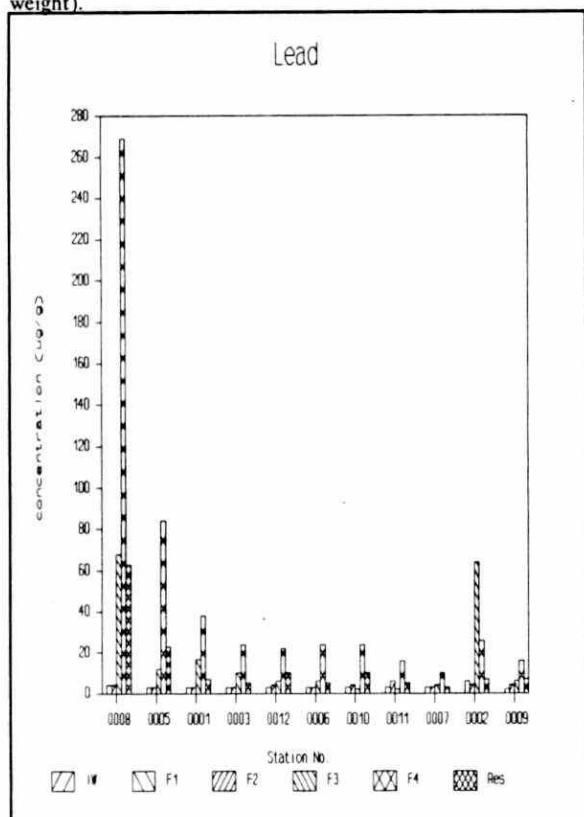


Figure 11: Geochemical Distribution of Lead in Sediment (wet weight).

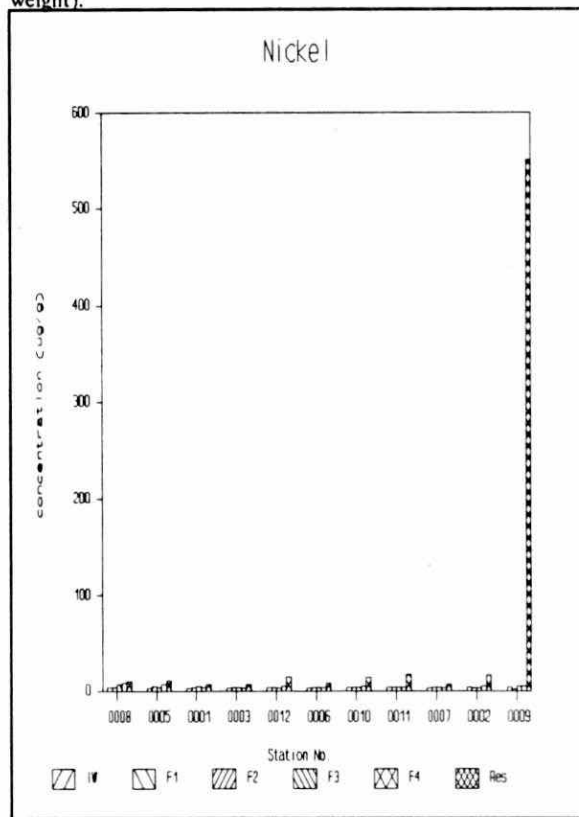


Figure 12: Geochemical Distribution of Nickel in Sediment (wet weight).

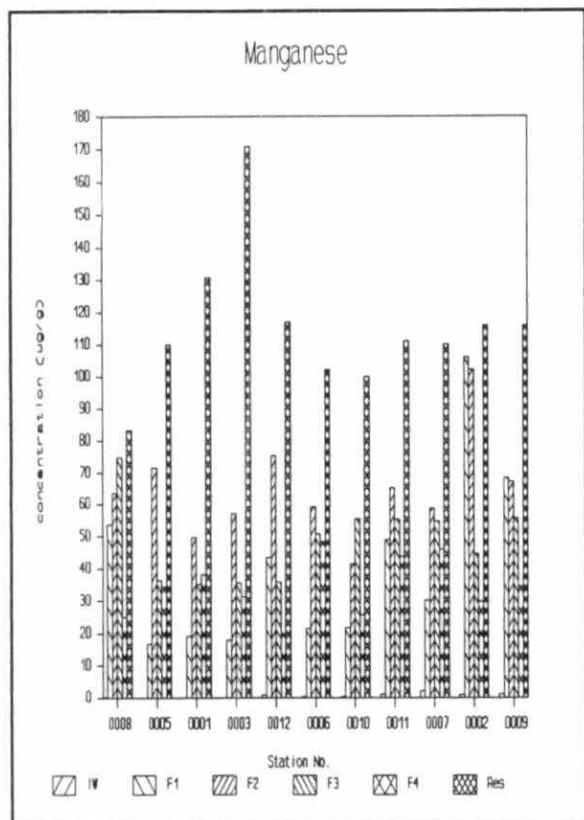


Figure 13: Geochemical Distribution of Manganese in Sediment (wet weight).

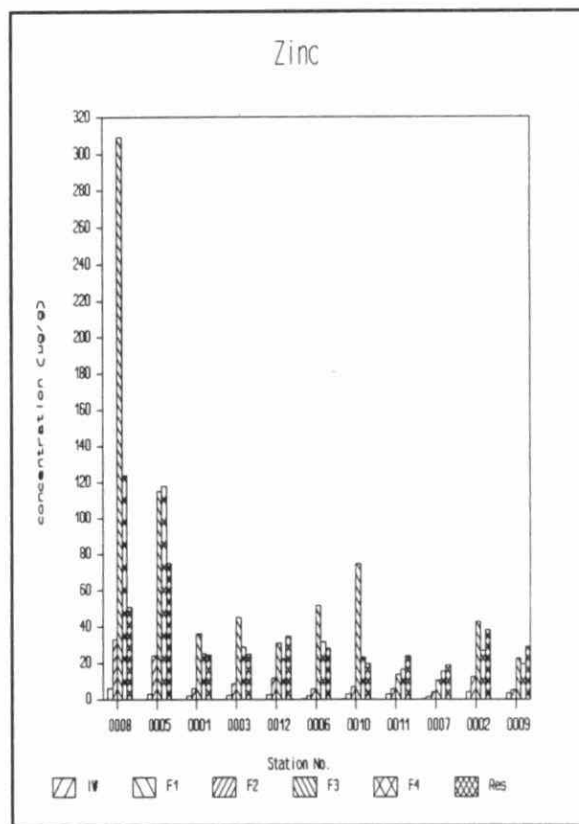
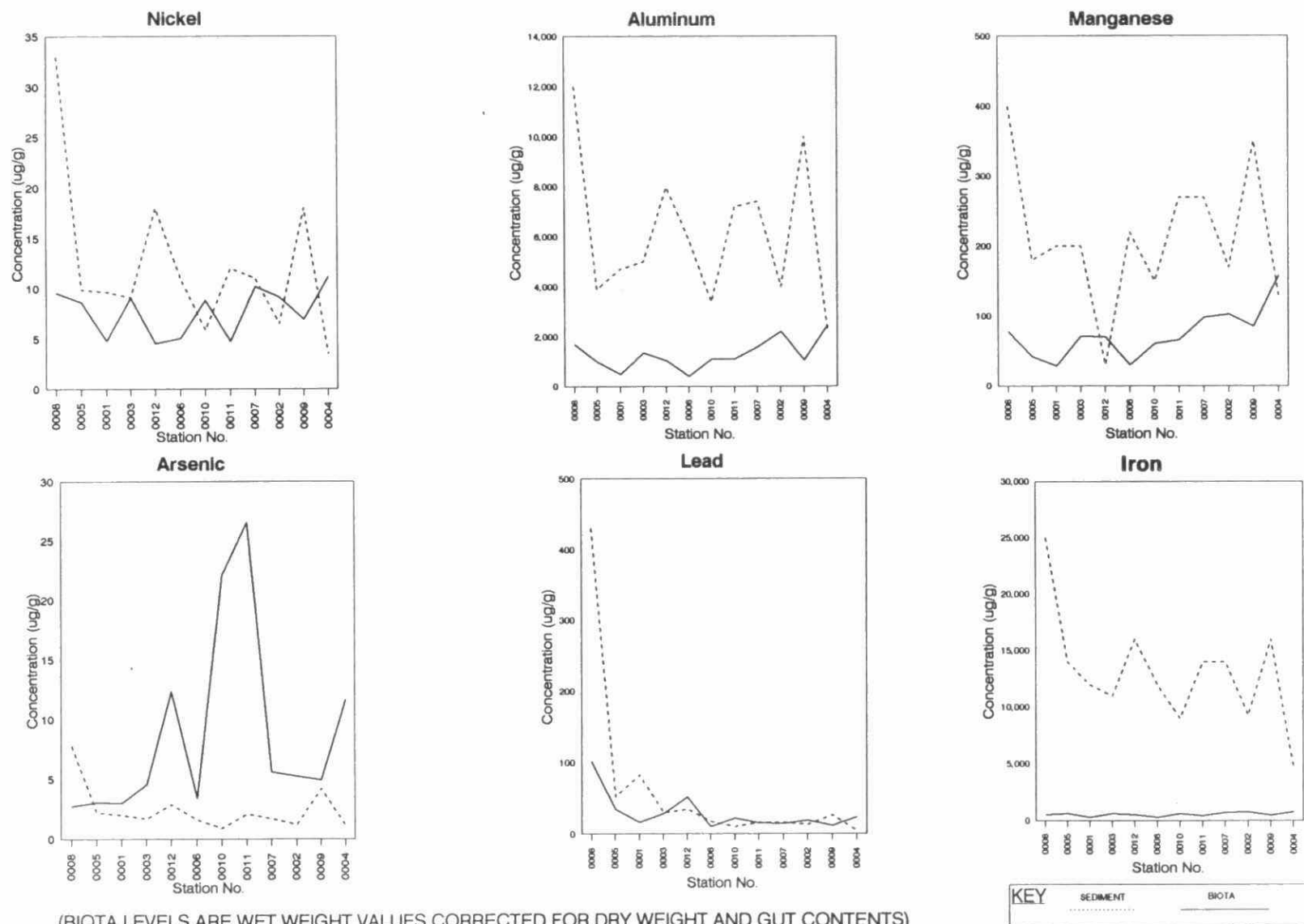


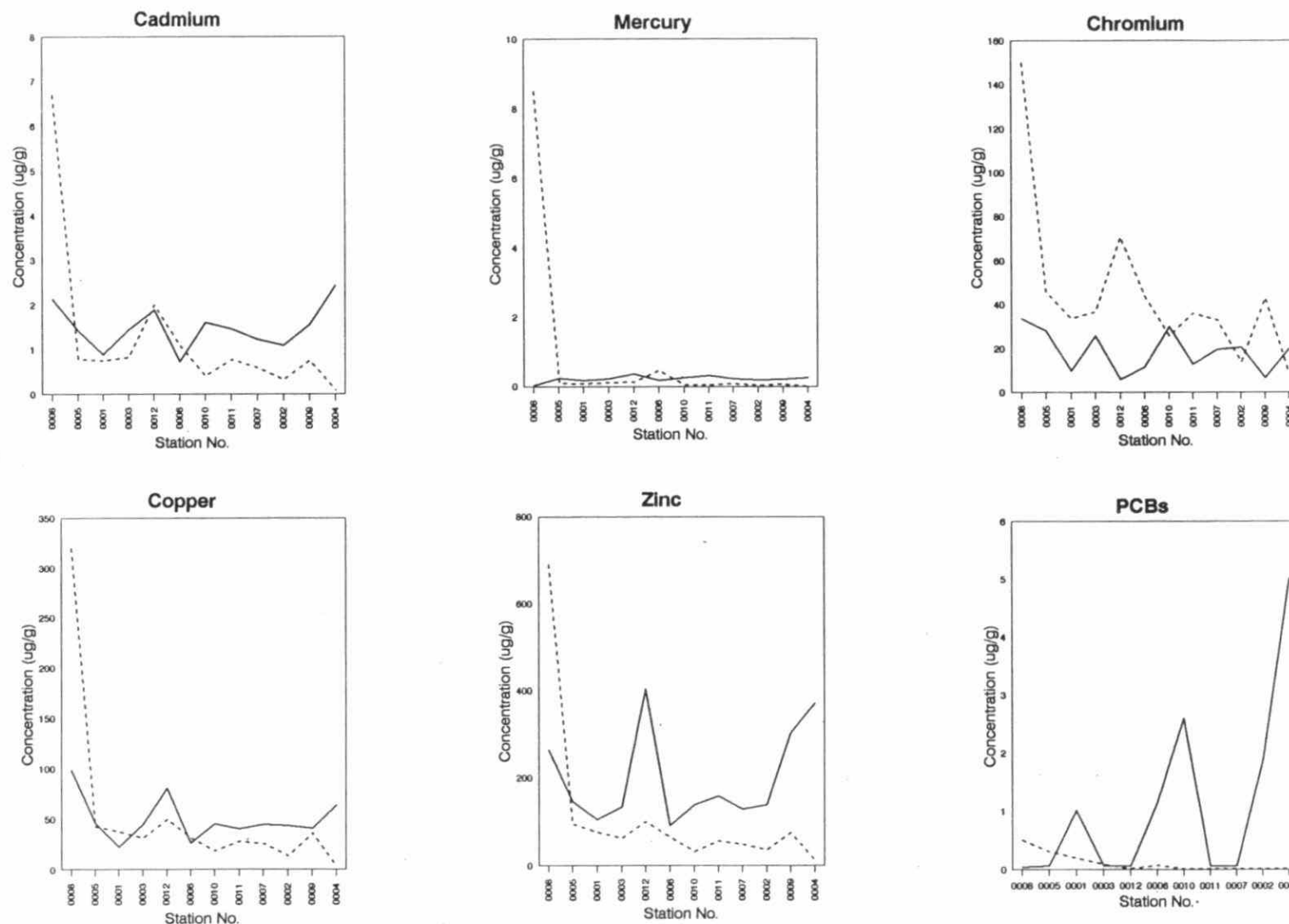
Figure 14: Geochemical Distribution of Zinc in Sediment (wet weight).

Figure 15: RELATIONSHIP OF BULK SEDIMENT CONTAMINANTS TO INVERTEBRATE TISSUE LEVELS. TORONTO MAIN STP, 1987.



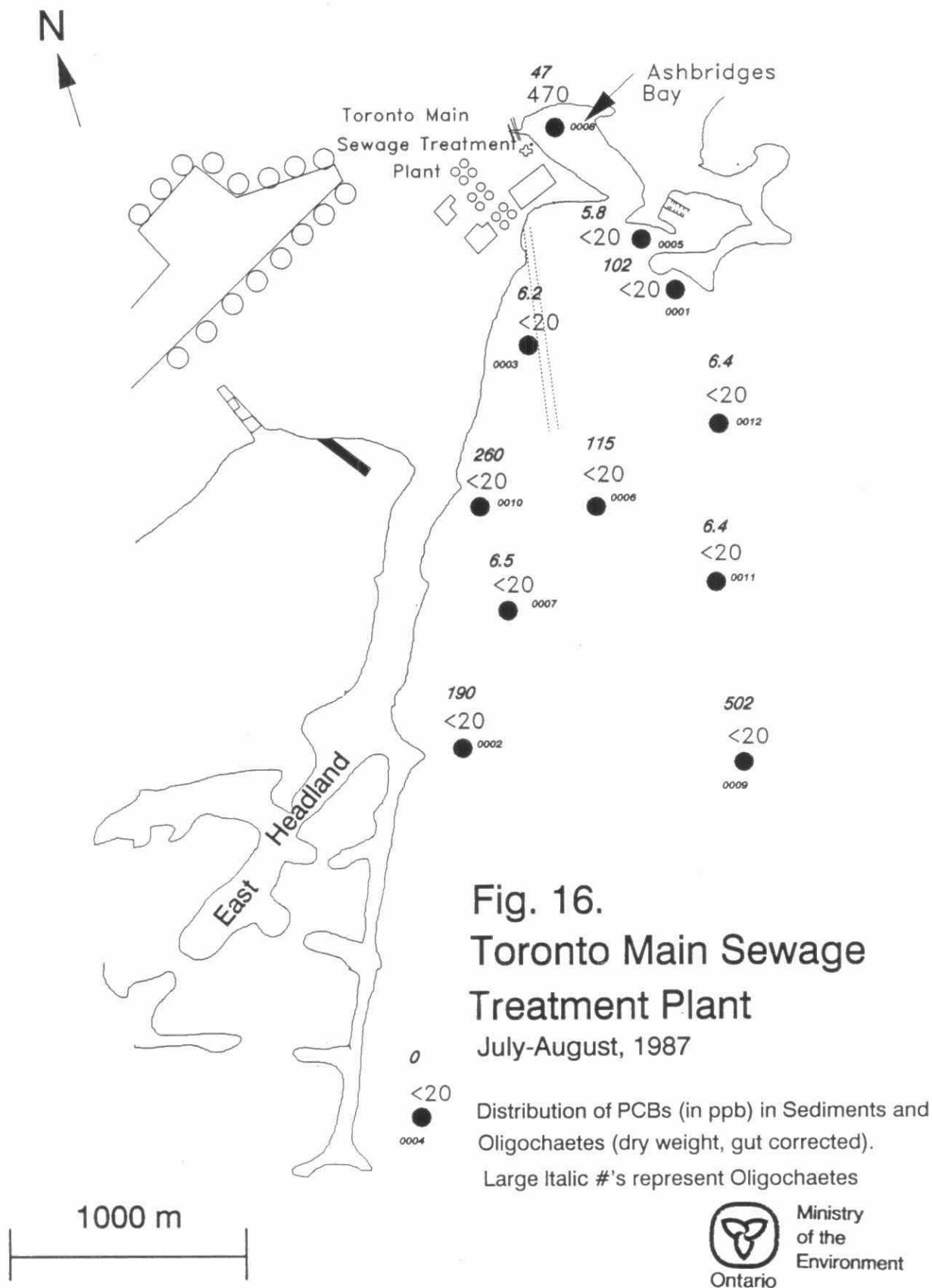
(BIOTA LEVELS ARE WET WEIGHT VALUES CORRECTED FOR DRY WEIGHT AND GUT CONTENTS)

Figure 15: (CONTINUED)



(BIOTA LEVELS ARE WET WEIGHT VALUES CORRECTED FOR DRY WEIGHT AND GUT CONTENTS)





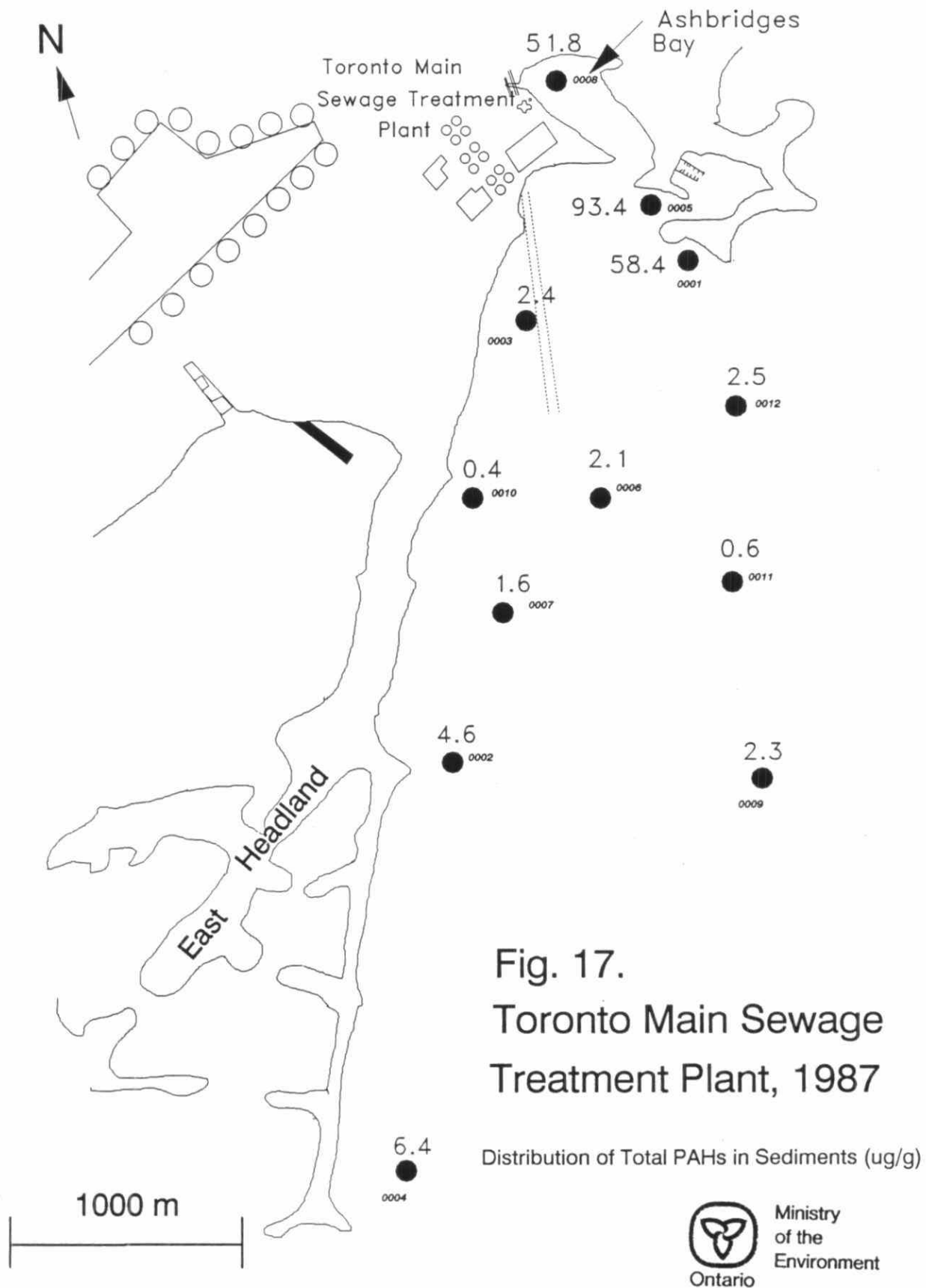


Fig. 17.
Toronto Main Sewage
Treatment Plant, 1987

Distribution of Total PAHs in Sediments (ug/g)

**Fig. 18. Levels of Selected PAHs in Sediments
in Relation to Organic Carbon**

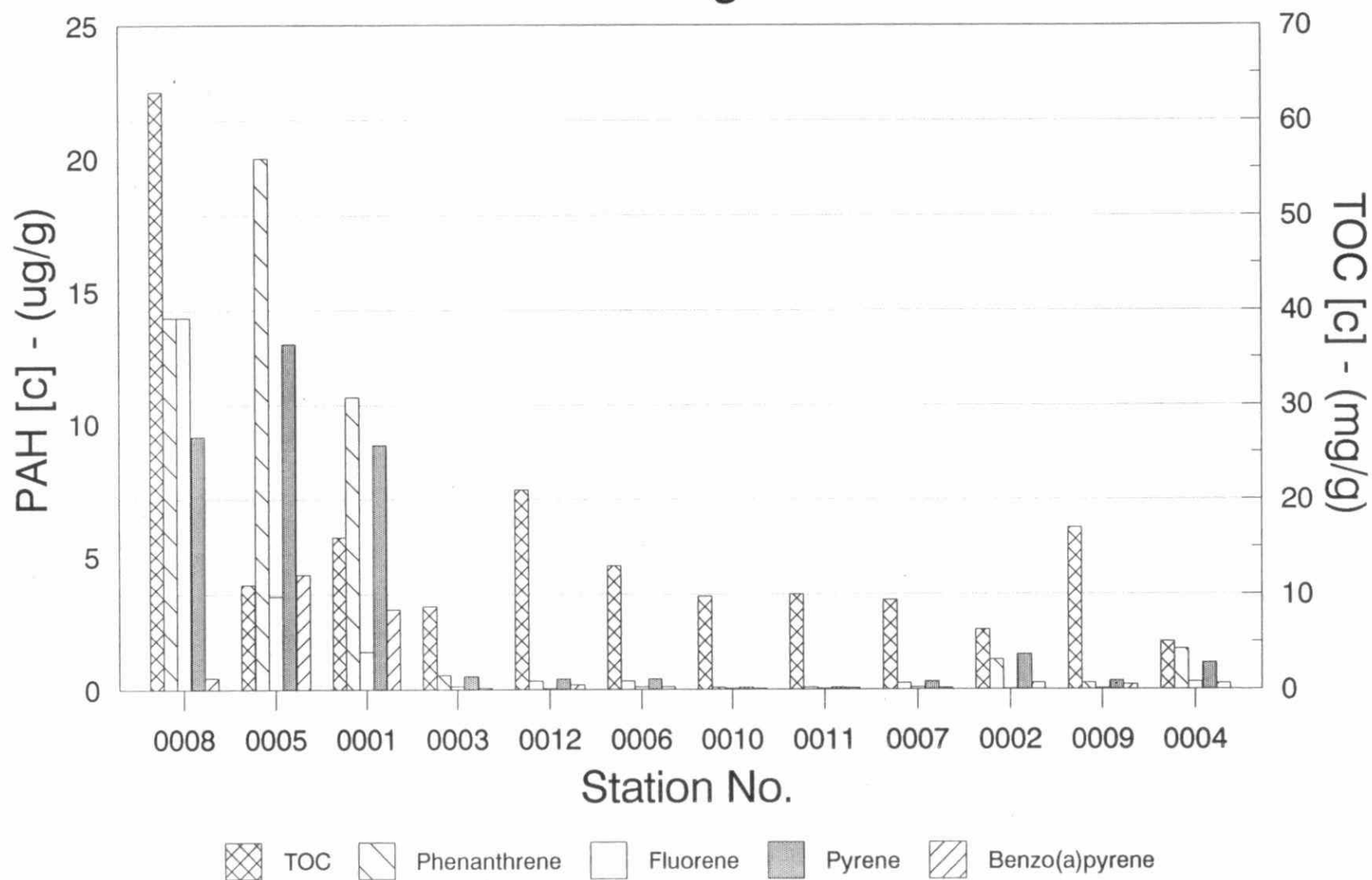
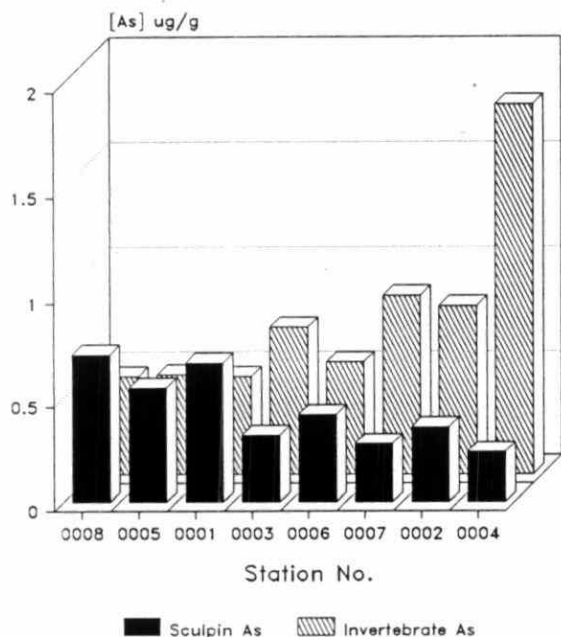
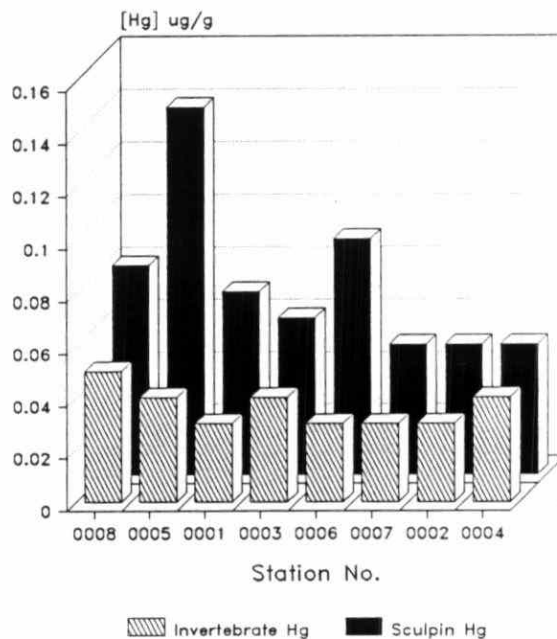


Fig 19a: Levels of Arsenic in Sculpins and Invertebrates



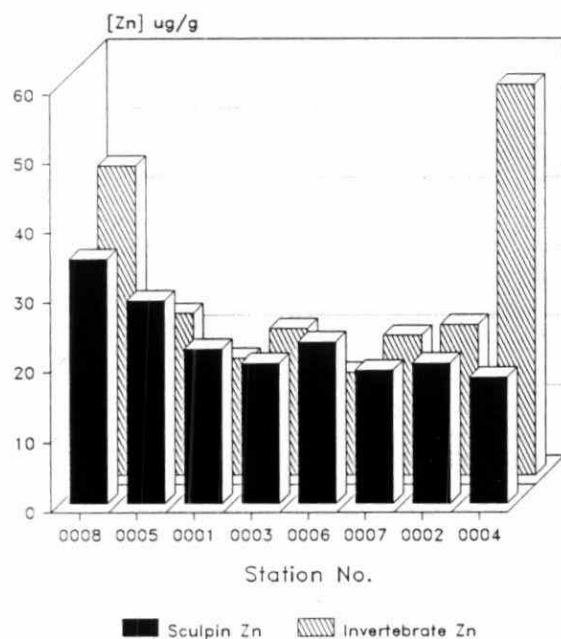
Levels calculated on wet weight basis

Fig 19b: Levels of Mercury in Sculpins and Invertebrates



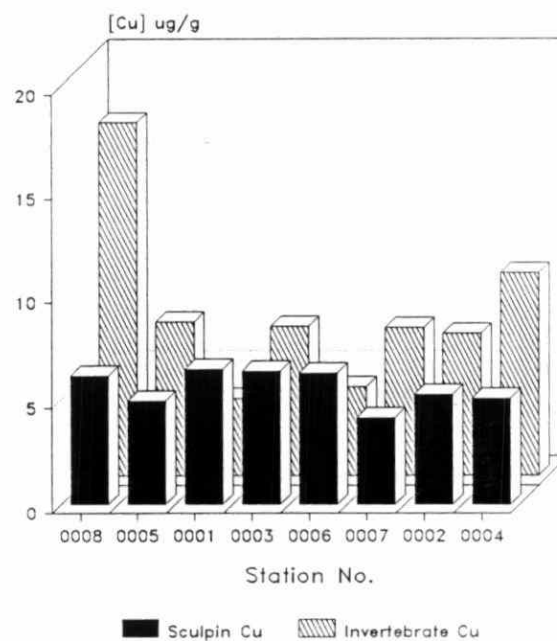
Levels calculated on wet weight basis

Fig 19c: Levels of Zinc in Sculpins and Invertebrates

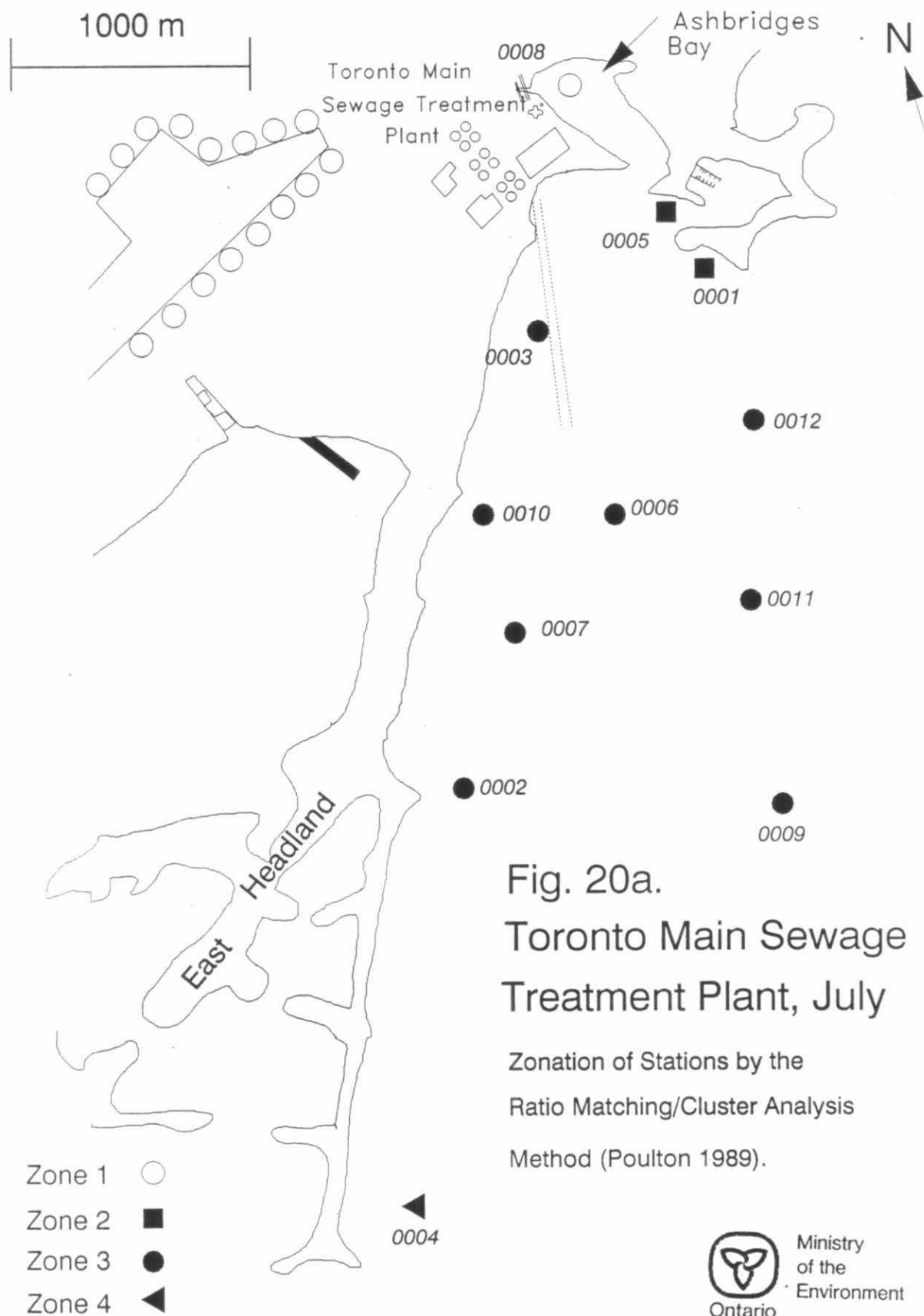


Levels calculated on wet weight basis

Fig 19d: Levels of Copper in Sculpins and Invertebrates



Levels calculated on wet weight basis



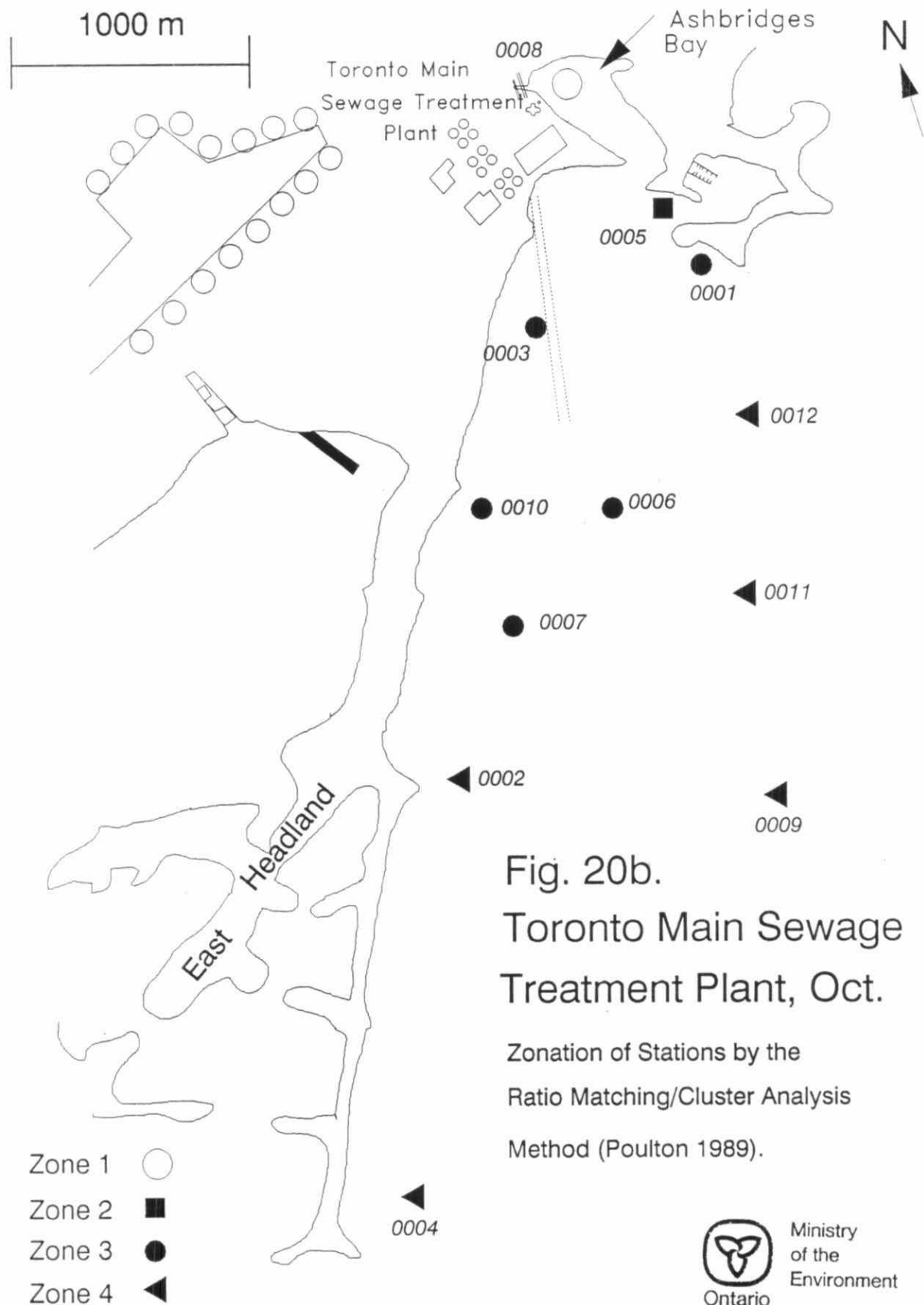


TABLE 1: In-Place Pollutants Program

1987 Toronto STP Study (JULY-AUGUST)

Water - Nutrients

Units: mg/l unless otherwise stated

| Station | Depth (m) | Conductivity @ 25 c umho/cm | Hard- ness | Sodium | Potassium | Alkal- inity | Calcium | pH | Acidity Total | Fluoride | Sulphate | Residue Filtrate | Residue Partic- ulate | Turbid- ity (FTU) | Colour True (MU) | Phos- phorous | Nitr'n Total | Ammonium Total | Nitrates Total | Nitrite Frac. React. | Phen- olics ug/L | Chemical Oxygen | Dissolved Organic Carbon | Dissolved Inorganic Carbon |
|---------|--------------|-----------------------------------|---------------|--------|-----------|-----------------|---------|------|------------------|----------|----------|---------------------|-----------------------------|-------------------------|------------------------|------------------|-----------------|-------------------|-------------------|----------------------------|------------------------|--------------------|--------------------------------|----------------------------------|
| 0008 | 2.5 | 457.0 | 138.0 | 27.4 | 2.56 | 125.7 | 36.0 | 7.70 | 3.32 | 0.21 | 27.3 | 297.0 CR | 12.7 | 7.7 | 13.0 | 0.142 | - | 2.590 | 0.38 | 0.0835 | - | 14.8 | 4.0 | 28.8 |
| 0005 | 2.0 | 356.0 | 135.0 | 15.9 | 1.98 | 106.7 | 37.0 | 8.01 | 0.97 | 0.18 | 26.5 | 231.0 CR | 6.1 | 3.7 | 5.0 | 0.076 | - | 1.400 | 0.30 | 0.0540 | - | 10.4 | 2.8 | 23.8 |
| 0001 | 6.0 | 325.0 | 130.0 | 12.8 | 1.63 | 100.3 | 37.0 | 8.11 | - | 0.15 | 25.5 | 211.0 CR | 9.0 | 5.3 | 3.0 | 0.010 | - | 0.584 | 0.21 | 0.0230 | - | 4.4 | 2.4 | 22.4 |
| 0003 | 6.0 | 314.0 | 128.0 | 12.0 | 1.54 | 97.7 | 38.0 | 8.23 | - | 0.13 | 24.7 | 204.0 CR | 35.5 | 12.8 | 2.0 <T | 0.210 | 0.42 | 0.208 | 0.18 | 0.0135 | - | 12.4 | 2.1 | 21.8 |
| 0012 | 9.0 | 312.0 | 125.0 | 12.2 | 1.50 | 97.9 | 35.0 | 8.41 | - | 0.12 | 26.3 | 203.0 CR | 3.9 | 1.3 | 1.5 <T | 0.018 | 0.32 | 0.168 | 0.17 | 0.0060 | - | 3.6 | 2.1 | 21.6 |
| 0006 | 7.0 | 311.0 | 128.0 | 11.9 | 1.50 | 96.9 | 37.0 | 8.43 | - | 0.13 | 24.3 | 202.0 CR | 2.1 <T | 1.8 | 2.0 <T | 0.014 | 0.27 | 0.108 | 0.17 | 0.0070 | - | 3.8 | 2.0 | 21.2 |
| 0010 | 5.5-6.0 | 317.0 | 130.0 | 12.2 | 1.57 | 99.5 | 36.0 | 8.23 | - | 0.12 | 24.8 | 206.0 CR | 3.7 | 3.1 | 2.5 | 0.039 | 0.41 | 0.310 | 0.19 | 0.0100 | - | 4.0 | 2.1 | 22.0 |
| 0011 | 9.5 | 313.0 | 129.0 | 12.0 | 1.53 | 97.7 | 36.0 | 8.34 | - | 0.12 | 25.5 | 203.0 CR | 6.3 | 2.9 | 2.0 <T | 0.035 | 0.22 | 0.100 | 0.18 | 0.0100 | - | 3.4 | 2.1 | 21.4 |
| 0007 | 7.5 | 313.0 | 130.0 | 12.1 | 1.50 | 98.1 | 35.0 | 8.35 | - | 0.12 | 24.1 | 203.0 CR | 3.2 | 2.6 | 2.5 | 0.031 | 0.29 | 0.148 | 0.17 | 0.0080 | - | 3.4 | 2.1 | 21.6 |
| 0002 | 12.0 | 315.0 | 128.0 | 12.0 | 1.50 | 98.0 | 36.0 | 8.35 | - | 0.12 | 24.9 | 205.0 CR | 5.3 | 4.0 | 2.0 <T | 0.097 | 0.32 | 0.136 | 0.18 | 0.0085 | - | 3.0 | 2.1 | 21.6 |
| 0009 | 14.5 | 313.0 | 129.0 | 11.9 | 1.50 | 98.5 | 43.0 | 8.25 | - | 0.12 | 24.6 | 203.0 CR | 3.6 | 2.2 | 2.0 <T | 0.015 | 0.26 | 0.074 | 0.20 | 0.0085 | - | 1.0 | 2.0 | 21.8 |
| 0004 | 15.0 | 313.0 | 129.0 | 11.9 | 1.50 | 98.7 | 36.0 | 8.27 | - | 0.12 | 24.9 | 203.0 CR | 2.2 <T | 1.7 | 1.5 <T | 0.012 | 0.20 | 0.066 | 0.19 | 0.0075 | - | 2.7 | 2.0 | 21.6 |

< Less than detection limit

<T Tentative value, for information only

CR Calculated result

- no data

TABLE 2: In-Place Pollants Program

1987 Toronto Harbour STP Study

Water - Metals

Units: mg/l, unless otherwise stated

| Station | Depth (m) | Field pH | Field EH | Copper | Chromium | Mercury | Cadmium | Iron | Lead | Zinc | Arsenic | Manganese | Aluminum | Nickel |
|---------|--------------|-------------|-------------|--------|----------|---------|----------|---------|---------|---------|---------|-----------|----------|---------|
| | | | | | | ug/L | | | | | | | | |
| 0008 | 2.5 | 7.30 | - | 0.001 | < 0.001 | 0.01 | < 0.0003 | 0.017 | < 0.003 | < 0.001 | < 0.001 | 0.003 | 0.055 | < 0.002 |
| 0005 | 2.0 | 7.87 | - | 0.004 | 0.002 | 0.04 | < 0.0003 | 0.190 | < 0.003 | < 0.001 | < 0.001 | 0.009 | 0.110 | 0.002 |
| 0001 | 6.0 | 8.02 | - | 0.004 | 0.003 | 0.05 | 0.0110 | 0.580 | < 0.003 | < 0.001 | < 0.001 | 0.010 | 0.200 | 0.002 |
| 0003 | 6.0 | 8.15 | - | 0.010 | 0.008 | 0.06 | 0.0003 | 1.200 | < 0.003 | 0.020 | < 0.001 | 0.022 | 0.710 | 0.002 |
| 0012 | 9.0 | 8.26 | - | 0.001 | < 0.001 | 0.01 | < 0.0003 | < 0.001 | < 0.003 | < 0.001 | < 0.001 | 0.001 | 0.025 | < 0.002 |
| 0006 | 7.0 | 8.27 | - | 0.001 | < 0.001 | 0.03 | < 0.0003 | 0.043 | < 0.003 | < 0.001 | < 0.001 | 0.002 | 0.034 | < 0.002 |
| 0010 | 5.5-6.0 | 8.05 | - | 0.001 | 0.001 | < 0.01 | < 0.0003 | 0.130 | < 0.003 | < 0.001 | < 0.001 | 0.004 | 0.068 | < 0.002 |
| 0011 | 9.5 | 8.21 | - | 0.002 | 0.001 | 0.01 | < 0.0003 | 0.260 | < 0.003 | < 0.001 | < 0.001 | 0.009 | 0.240 | < 0.002 |
| 0007 | 7.5 | 8.25 | - | 0.001 | < 0.001 | < 0.01 | < 0.0003 | 0.061 | < 0.003 | < 0.001 | < 0.001 | 0.003 | 0.050 | < 0.002 |
| 0002 | 12.0 | 8.09 | - | 0.001 | 0.001 | 0.03 | < 0.0003 | 0.160 | < 0.003 | < 0.001 | < 0.001 | 0.005 | 0.140 | < 0.002 |
| 0009 | 14.5 | 8.04 | - | 0.009 | 0.002 | 0.01 | < 0.0003 | 0.730 | 0.005 | 0.004 | < 0.001 | 0.058 | 0.230 | 0.003 |
| 0004 | 15.0 | 7.99 | - | 0.001 | < 0.001 | 0.05 | < 0.0003 | 0.029 | < 0.003 | < 0.001 | < 0.001 | 0.001 | 0.027 | < 0.002 |

< Less than detection limit

- No data

TABLE 3: In-Place Pollutants Program
 1987 Toronto STP Study (JULY-AUGUST)
 Water - PCBs and Pesticides
 Units: ng/L, unless otherwise stated

| Station | Depth (m) | Aldrin | A-BHC Hexa- chloro- cyclo- hexane | B-BHC Hexa- chloro- cyclo- hexane | G-BHC Hexa- chloro- cyclo- hexane | A Chlor- dane | G Chlor- dane | Dieldrin | DMDT Meth- oxychlor | Endo- sulfan I | Endo- sulfan II | Octa- chloro- styrene | Endrin | Endo- sulfan sulfate | Hepta- chlor- epoxide | Hepta- chlor | Mirex | Oxy- chloro- dane | OP-DDT | PCB Total | PP-DDD | PP-DDE | PP-DDT | Hexa chlo benz |
|---------|--------------|--------|---|---|---|---------------------|---------------------|----------|---------------------------|----------------------|-----------------------|-----------------------------|--------|----------------------------|-----------------------------|-----------------|-------|-------------------------|--------|--------------|--------|--------|--------|----------------------|
| 0008 | 2.5 | < 1 | 3 <T | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0005 | 2.0 | < 1 | 3 <T | 2 <T | 2 <T | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0001 | 6.0 | < 1 | 4 <T | < 1 | 2 <T | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0003 | 6.0 | < 1 | 3 <T | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0012 | 9.0 | < 1 | < 1 | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0006 | 7.0 | < 1 | 3 <T | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0010 | 5.5-6.0 | < 1 | 3 <T | < 1 | 1 <T | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0011 | 9.5 | < 1 | 4 <T | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0007 | 7.5 | < 1 | < 1 | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0002 | 12.0 | < 1 | 2 <T | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0009 | 14.5 | < 1 | 3 <T | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |
| 0004 | 15.0 | < 1 | 3 <T | < 1 | 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 1 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 |

< Lower than detection limit
 <T Tentative value, for information only

TABLE 4: In-Place Pollutants Program

1987 Toronto STP Study (JULY-AUGUST)

Water - Organics

Units: ng/L, unless otherwise stated

| Station | Depth (m) | Hexa- chloro- ethane | 1,3,5 Trichloro- benzene | 1,2,4 Trichloro- benzene | Hexa- chloro- butadiene | 1,2,3 Trichloro- benzene | 2,4,5 Trichloro- toluene | 2,3,6 Trichloro- toluene | 1,2,3,5 Tetrachloro- benzene | 1,2,4,5 Tetrachloro- benzene | 2,6,a Trichloro- toluene | Tetra- chloro- benzene | Penta- chloro- benzene |
|---------|--------------|----------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------|--------------------------------|--------------------------------|------------------------------------|------------------------------------|--------------------------------|------------------------------|------------------------------|
| 0008 | 2.5 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0005 | 2.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0001 | 6.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0003 | 6.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0012 | 9.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0006 | 7.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0010 | 5.5-6.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0011 | 9.5 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0007 | 7.5 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0002 | 12.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0009 | 14.5 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |
| 0004 | 15.0 | < 1 | < 5 | < 5 | < 1 | < 5 | < 5 | < 5 | < 1 | < 1 | < 5 | < 1 | < 1 |

< Less than detection limit

TABLE 5: In-Place Pollutants Program
Sediment - Particle Size by Percentage
Toronto Main STP, 1987
(JULY-AUGUST)

| Station | Gravel > 1000 um | Sand 1000-44 um | Silt 42.21-3.73 um | Clay 3.73-0.17 um |
|---------|---------------------|--------------------|-----------------------|----------------------|
| 0008 | 0.2 | 30.1 | 52.8 | 13.9 |
| 0005 | 0.3 | 89.7 | 5.8 | 1.8 |
| 0001 | 0.2 | 79.3 | 16.2 | 2.0 |
| 0003 | < 0.1 | 64.9 | 26.3 | 4.5 |
| 0012 | 0.4 | 43.4 | 45.5 | 8.4 |
| 0006 | < 0.1 | 58.0 | 33.2 | 3.9 |
| 0010 | < 0.1 | 80.5 | 11.5 | 2.0 |
| 0011 | 0.1 | 54.3 | 37.2 | 4.9 |
| 0007 | < 0.1 | 43.9 | 47.3 | 4.1 |
| 0002 | 0.8 | 82.2 | 12.0 | 2.2 |
| 0009 | < 0.1 | 45.6 | 42.2 | 9.9 |
| 0004 | 1.9 | 91.5 | 5.2 | 1.0 |

(OCTOBER)

Units: um

| Station | Gravel >1000 | Sand 1000-44 | Silt 42.21-3.73 | Clay 3.73-0.17 |
|---------|-----------------|-----------------|--------------------|-------------------|
| 0008 | - | - | - | - |
| 0005 | 0.8 | 62.80 | 28.9 | 3.70 |
| 0001 | 0.3 | 79.90 | 13.7 | 1.70 |
| 0003 | < 0.1 | 74.70 | 17.8 | 2.30 |
| 0012 | 14.5 | 76.70 | 7.1 | 1.10 |
| 0006 | < 0.1 | 41.90 | 50.1 | 3.00 |
| 0010 | < 0.1 | 58.50 | 33.2 | 2.80 |
| 0011 | 0.1 | 90.60 | 6.8 | 1.50 |
| 0007 | < 0.1 | 28.70 | 61.1 | 5.50 |
| 0002 | 0.3 | 93.30 | 4.6 | 0.90 |
| 0009 | 0.1 | 89.20 | 7.5 | 1.80 |
| 0004 | 0.8 | 91.20 | 6.4 | 1.00 |

< Lower than detection limit

- No data

TABLE 6: In-Place Pollutants Program
Sediment - Metals
Toronto Main STP, 1987

* Equals or exceeds MOE guidelines for open water disposal of dredged material
* EH at 3cm
- No data
<T This low measurement is tentative - for information only
< Lower than detection limit

(JULY-AUGUST)

Units: Dry Weight

| Station | Depth m | Field pH | Field EH | Loss on Ignition LOI % | Phos- phorous mg/g | Total Kjeldahl Nitrogen mg/g | Total Organic Carbon mg/g | Copper ug/g | Chromium ug/g | Mercury ug/g | Cadmium ug/g | Iron ug/g | Lead ug/g | Zinc ug/g | Arsenic ug/g | Manganese ug/g | Alum- inum ug/g | Nickel ug/g | Solvent Extractables ug/g |
|---------|------------|-------------|-------------|------------------------------|--------------------------|---------------------------------------|------------------------------------|----------------|------------------|-----------------|-----------------|--------------|--------------|--------------|-----------------|-------------------|-----------------------|----------------|---------------------------------|
| 0008 | 2.5 | 6.80 | - 140 | 10.0 * | 3.5 * | 4.0 * | 63.0 * | 320.0 * | 150.0 * | 8.50 * | 6.70 | * 25000 | 430.0 * | 690.0 * | 7.80 | 400.0 | 12000 | 33.0 | 13510 * |
| 0005 | 2.0 | 7.15 | - 207 | 2.5 | 3.4 * | 0.7 | 11.0 * | 43.0 * | 46.0 * | 0.10 | 0.79 | 14000 | 52.0 * | 95.0 | 2.20 | 180.0 | 3900 | 9.9 | 4363 * |
| 0001 | 6.0 | 7.05 | - 225 | 2.2 | 1.3 * | 0.8 | 16.0 * | 38.0 * | 34.0 * | 0.09 | 0.76 | 12000 | 82.0 * | 77.0 | 2.00 | 200.0 | 4700 | 9.7 | 3059 * |
| 0003 | 6.0 | 6.90 | - 192 | 2.1 | 1.6 * | 1.2 | 8.7 | 31.0 * | 37.0 * | 0.12 | 0.83 | 11000 | 29.0 | 63.0 | 1.70 | 200.0 | 5000 | 9.1 | 1441 |
| 0012 | 9.0 | 6.93 | - 178 | 3.9 | 1.7 * | 1.9 | 21.0 * | 50.0 * | 71.0 * | 0.14 | 2.00 | * 16000 | 34.0 | 100.0 * | 2.90 | 30.0 | 8000 | 18.0 | 3080 * |
| 0006 | 7.0 | 6.75 | - 180 | 2.2 | 1.7 * | 1.2 | 13.0 * | 32.0 * | 44.0 * | 0.46 * | 1.10 | * 12000 | 18.0 | 65.0 | 1.60 | 220.0 | 5900 | 11.0 | 2387 * |
| 0010 | 5.5-6.0 | 7.19 | - 97 | 0.9 | 1.3 * | 0.5 | 9.8 | 19.0 | 26.0 * | 0.05 | 0.41 | 9000 | 10.0 | 32.0 | 0.93 | 150.0 | 3400 | 5.9 | 553 |
| 0011 | 9.5 | 7.25 | - 180 | 2.4 | 1.0 * | 1.4 | 10.0 * | 28.0 * | 36.0 * | 0.05 | 0.78 | 14000 | 16.0 | 56.0 | 2.10 | 270.0 | 7200 | 12.0 | 387 |
| 0007 | 7.5 | 7.07 | - 184 | 2.0 | 1.2 * | 0.8 | 9.4 | 26.0 * | 33.0 * | 0.09 | 0.60 | 14000 | 16.0 | 49.0 | 1.70 | 270.0 | 7400 | 11.0 | 1200 |
| 0002 | 12.0 | 7.38 | - 196 | 1.3 | 1.0 * | 0.5 | 6.3 | 14.0 | 14.0 | 0.04 | 0.33 | 9300 | 13.0 | 36.0 | 1.20 | 170.0 | 4000 | 6.5 | 1723 * |
| 0009 | 14.5 | 6.79 | - 177 | 3.3 | 1.5 * | 1.6 | 17.0 * | 36.0 * | 43.0 * | 0.07 | 0.75 | 16000 | 26.0 | 75.0 | 4.20 | 350.0 | 10000 | 18.0 | 877 |
| 0004 | 15.0 | 7.52 | 117 | 1.0 | 0.5 | 0.2 <T | < 5.0 | 3.7 | 9.0 | 0.01 | < 0.20 | 4900 | 4.4 | 12.0 | 1.10 | 130.0 | 2300 | 3.5 | 1136 |

(OCTOBER)

Units: Dry Weight

| Station | Field Ph | Field EH | Loss on Ignition % | Phosphorous mg/g | Total Kjeldahl Nitrogen mg/g | Total Organic Carbon mg/g | Copper ug/g | Chromium ug/g | Mercury ug/g | Cadmium ug/g | Iron ug/g | Lead ug/g | Zinc ug/g | Arsenic ug/g | Manganese ug/g | Aluminum ug/g | Nickel ug/g | Solvent Extractables ug/g |
|---------|-------------|-------------|--------------------------|---------------------|---------------------------------------|------------------------------------|----------------|------------------|-----------------|-----------------|--------------|--------------|--------------|-----------------|-------------------|------------------|----------------|---------------------------------|
| 0008 | - | - | 17.0 * | 3.59 * | 4.13 * | 67.0 * | 440.0 * | 210.0 * | 1.00 | 8.20 * | 28000 * | 480.0 * | 890.0 * | 8.10 * | 450.0 | 15000 | 37.0 | 2788 * |
| 0005 | - | - | 8.9 * | 7.82 * | 2.99 * | 63.0 * | 150.0 * | 160.0 * | 0.34 * | 3.90 * | 24000 * | 120.0 * | 310.0 * | 4.60 | 270.0 | 7400 | 24.0 | 3890 * |
| 0001 | - | - | 2.1 | 1.99 * | 0.56 | < 5.0 | 36.0 * | 32.0 * | 0.09 | 0.68 | 13000 * | 63.0 * | 78.0 | 1.50 | 210.0 | 4300 | 11.0 | 2050 * |
| 0003 | - | - | 1.3 | 1.61 * | 0.41 | 12.0 * | 31.0 * | 34.0 * | 0.13 | 0.77 | 11000 * | 29.0 | 65.0 | 1.40 | 180.0 | 4100 | 7.6 | 5490 * |
| 0012 | - | - | 0.5 | 0.41 | 0.13 <T | 5.0 | 5.9 | 11.0 | 0.01 | < 0.20 | 5200 | 4.6 | 17.0 | 1.20 | 190.0 | 2700 | 3.5 | 70 |
| 0006 | - | - | 1.8 | 1.99 * | 0.75 | 12.0 * | 31.0 * | 36.0 * | 0.08 | 0.77 | 12000 * | 17.0 | 66.0 | 1.40 | 240.0 | 6000 | 10.0 | 690 |
| 0010 | - | - | 2.3 | 3.14 * | 1.02 | 14.0 * | 49.0 * | 59.0 * | 0.43 * | 1.80 * | 14000 * | 29.0 | 100.0 * | 1.40 | 200.0 | 5000 | 10.0 | 1090 |
| 0011 | - | - | 0.5 | 0.59 | 0.16 <T | 5.0 | 5.8 | 12.0 | 0.02 | < 0.20 | 11000 | 8.1 | 22.0 | 1.30 | 160.0 | 2900 | 3.6 | 220 |
| 0007 | - | - | 3.3 | 3.47 * | 1.28 | 19.0 * | 53.0 * | 60.0 * | 0.11 | 1.50 * | 18000 * | 29.0 | 110.0 * | 1.90 | 310.0 | 7900 | 15.0 | 2270 * |
| 0002 | - | - | 0.5 | 0.87 | 0.19 <T | 5.0 | 6.4 | 15.0 | 0.01 | < 0.20 | 17000 * | 7.9 | 20.0 | 0.76 | 200.0 | 3000 | 3.3 | 640 |
| 0009 | - | - | 0.7 | 1.22 * | 0.24 <T | 5.0 | 4.3 | 16.0 | 0.01 | < 0.20 | 19000 * | 9.8 | 20.0 | 1.20 | 250.0 | 3500 | 3.5 | 160 |
| 0004 | - | - | 0.8 | 0.64 | 0.13 <T | 5.0 | 8.9 | 11.0 | 0.01 | < 0.20 | 8300 | 9.3 | 25.0 | 0.87 | 160.0 | 3100 | 4.1 | 410 |

TABLE 7: In-Place Pollutants Program

Sediment - Geochemical Distribution of Metals

Toronto Main STP, 1987

UNITS: ppm, wet weight

ARSENIC

| LOCATION | STATION | IW | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|---------|---------|-------|---------|-------|----------|-------|-------|
| TORONTO (STP) | 0008 | < 0.001 | 0.179 | 0.687 | 0.139 | 1.780 | 2.710 | 4.440 | 5.316 |
| TORONTO (STP) | 0005 | - | < 0.040 | 0.495 | 0.255 | 1.270 | 1.370 | 5.000 | 3.390 |
| TORONTO (STP) | 0001 | - | < 0.040 | 0.138 | 0.218 | 0.820 | 0.706 | 1.976 | 1.882 |
| TORONTO (STP) | 0003 | - | 0.052 | 0.179 | 0.255 | 0.799 | 0.604 | 2.030 | 1.837 |
| TORONTO (STP) | 0012 | 0.003 | 0.080 | 0.455 | 0.183 | 0.731 | 1.210 | 2.160 | 2.579 |
| TORONTO (STP) | 0006 | 0.006 | < 0.040 | 0.163 | 0.143 | 0.799 | 0.839 | 2.120 | 1.944 |
| TORONTO (STP) | 0010 | 0.010 | 0.060 | 0.243 | 0.127 | 0.731 | 0.714 | 1.660 | 1.815 |
| TORONTO (STP) | 0011 | 0.012 | 0.060 | 0.155 | 0.056 | 0.799 | 1.130 | 1.830 | 2.140 |
| TORONTO (STP) | 0007 | 0.010 | < 0.040 | 0.092 | 0.155 | 0.487 | 0.419 | 1.180 | 1.113 |
| TORONTO (STP) | 0002 | 0.015 | 0.159 | 0.335 | < 0.036 | 0.879 | 2.320 | 2.600 | 3.570 |
| TORONTO (STP) | 0009 | 0.011 | 0.100 | 0.267 | 0.076 | 1.170 | 1.470 | 2.700 | 2.983 |
| TORONTO (STP) | 0004 | 0.010 | - | - | - | - | - | 3.410 | 0.000 |

KEY: < Less than detection limit

- No data

ZINC

| LOCATION | STATION | IW | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|--------|-----|------|-------|-------|----------|-------|-------|
| TORONTO (STP) | 0008 | 0.04 | 6.2 | 33.1 | 309.0 | 124.0 | 51.1 | 518.0 | 889.4 |
| TORONTO (STP) | 0005 | - | 2.8 | 24.3 | 115.0 | 118.0 | 75.2 | 327.0 | 544.3 |
| TORONTO (STP) | 0001 | - | 2.0 | 6.1 | 36.3 | 25.2 | 24.4 | 131.0 | 94.0 |
| TORONTO (STP) | 0003 | - | 2.4 | 8.6 | 45.5 | 28.9 | 24.9 | 93.8 | 110.3 |
| TORONTO (STP) | 0012 | < 0.02 | 2.6 | 11.7 | 30.7 | 22.4 | 34.7 | 114.0 | 230.6 |
| TORONTO (STP) | 0006 | 0.13 | 2.0 | 6.0 | 51.8 | 31.6 | 28.0 | 122.0 | 209.8 |
| TORONTO (STP) | 0010 | 0.23 | 3.1 | 7.0 | 74.6 | 23.0 | 19.7 | 105.0 | 208.3 |
| TORONTO (STP) | 0011 | < 0.02 | 2.8 | 5.9 | 13.7 | 10.6 | 23.9 | 45.6 | 97.7 |
| TORONTO (STP) | 0007 | 0.23 | 1.7 | 4.0 | 10.6 | 15.4 | 18.9 | 52.2 | 87.4 |
| TORONTO (STP) | 0002 | < 0.01 | 4.0 | 12.1 | 42.7 | 26.7 | 38.5 | 73.8 | 124.0 |
| TORONTO (STP) | 0009 | 0.04 | 3.3 | 5.1 | 22.4 | 19.4 | 28.8 | 68.6 | 130.1 |
| TORONTO (STP) | 0004 | < 0.02 | - | - | - | - | - | 58.3 | 58.3 |

KEY: < Less than detection limit

- No data

LEAD

| LOCATION | STATION | IW | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|--------|-------|-------|--------|-----|----------|--------|-----|
| TORONTO (STP) | 0008 | < 0.05 | 4.0 | 4.0 | 68.00 | 269 | 63 | 354.0 | 493 |
| TORONTO (STP) | 0005 | < 0.05 | < 3.0 | < 3.0 | 12.00 | 84 | 23 | 127.0 | 162 |
| TORONTO (STP) | 0001 | - | < 3.0 | < 3.0 | 17.00 | 38 | 7 | 35.0 | 62 |
| TORONTO (STP) | 0003 | - | < 3.0 | < 3.0 | 10.00 | 24 | 5 | 35.0 | 39 |
| TORONTO (STP) | 0012 | < 0.05 | < 3.0 | 4.0 | 6.00 | 22 | 10 | 43.0 | 73 |
| TORONTO (STP) | 0006 | < 0.05 | < 3.0 | < 3.0 | 6.00 | 24 | 5 | 28.0 | 39 |
| TORONTO (STP) | 0010 | 0.06 | < 3.0 | 4.0 | < 2.00 | 24 | 10 | 33.0 | 51 |
| TORONTO (STP) | 0011 | < 0.05 | < 3.0 | 6.0 | 2.00 | 16 | 5 | 23.0 | 34 |
| TORONTO (STP) | 0007 | < 0.05 | < 3.0 | < 3.0 | 4.00 | 10 | 3 | < 10.0 | 17 |
| TORONTO (STP) | 0002 | < 0.05 | 6.0 | 4.0 | 64.00 | 26 | 7 | 66.0 | 107 |
| TORONTO (STP) | 0009 | < 0.05 | < 2.0 | 4.0 | 6.00 | 16 | 7 | 35.0 | 54 |
| TORONTO (STP) | 0004 | < 0.05 | - | - | - | - | - | 25.0 | 25 |

KEY: < Less than detection limit

- No data

CADMIUM

| LOCATION | STATION | IW | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|--------|-------|-------|--------|--------|----------|--------|-----|
| TORONTO (STP) | 0008 | < 0.01 | < 0.4 | < 0.4 | 3.60 | 2.10 | < 0.50 | 1.60 | 5.7 |
| TORONTO (STP) | 0005 | < 0.01 | < 0.4 | < 0.4 | 2.20 | 1.60 | 0.70 | 2.80 | 4.5 |
| TORONTO (STP) | 0001 | < 0.01 | < 0.4 | < 0.4 | 1.30 | 0.60 | < 0.50 | < 0.50 | 1.9 |
| TORONTO (STP) | 0003 | < 0.01 | < 0.4 | < 0.4 | 1.60 | < 0.40 | < 0.50 | < 0.50 | 1.6 |
| TORONTO (STP) | 0012 | < 0.01 | < 0.4 | < 0.4 | 1.10 | < 0.40 | < 0.50 | < 0.50 | 1.1 |
| TORONTO (STP) | 0006 | < 0.01 | < 0.4 | < 0.4 | 1.50 | < 0.40 | < 0.50 | < 0.50 | 1.5 |
| TORONTO (STP) | 0010 | < 0.01 | < 0.4 | < 0.4 | 1.60 | 1.30 | < 0.50 | < 0.50 | 2.9 |
| TORONTO (STP) | 0011 | < 0.01 | < 0.4 | < 0.4 | < 0.40 | < 0.40 | < 0.50 | < 0.50 | 0.0 |
| TORONTO (STP) | 0007 | < 0.01 | < 0.4 | < 0.4 | 0.50 | < 0.40 | < 0.50 | < 0.50 | 0.5 |
| TORONTO (STP) | 0002 | < 0.01 | < 0.4 | < 0.4 | < 0.40 | < 0.40 | < 0.50 | < 0.50 | 0.0 |
| TORONTO (STP) | 0009 | < 0.01 | < 0.4 | < 0.4 | < 0.40 | < 0.40 | < 0.50 | < 0.50 | 0.0 |
| TORONTO (STP) | 0004 | < 0.01 | - | - | - | - | - | - | 0.0 |

KEY: < Less than detection limit

- No data

ALUMINUM

| LOCATION | STATION | IW | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|--------|------|-------|------|------|----------|-------|-------|
| TORONTO (STP) | 0008 | < 0.01 | 36.3 | 4.0 | 475 | 900 | 9030 | 7810 | 10445 |
| TORONTO (STP) | 0005 | - | 31.3 | 4.0 | 290 | 1110 | 9130 | 8870 | 10565 |
| TORONTO (STP) | 0001 | - | 46.5 | < 0.1 | 198 | 894 | 8669 | 10214 | 9808 |
| TORONTO (STP) | 0003 | - | 38.2 | 6.8 | 209 | 795 | 9150 | 7420 | 10199 |
| TORONTO (STP) | 0012 | < 0.01 | 29.4 | < 0.1 | 310 | 588 | 11400 | 8920 | 12327 |
| TORONTO (STP) | 0006 | 2.36 | 31.1 | 1.7 | 200 | 868 | 8730 | 12200 | 9831 |
| TORONTO (STP) | 0010 | 1.73 | 30.2 | 3.4 | 256 | 688 | 6890 | 6960 | 7868 |
| TORONTO (STP) | 0011 | 0.13 | 30.8 | < 0.1 | 195 | 721 | 11000 | 8950 | 11947 |
| TORONTO (STP) | 0007 | 12.70 | 33.9 | 2.2 | 118 | 775 | 8440 | 12000 | 9369 |
| TORONTO (STP) | 0002 | 0.18 | 33.9 | 5.7 | 1140 | 1310 | 15600 | 9490 | 18090 |
| TORONTO (STP) | 0009 | 0.41 | 34.1 | < 0.1 | 236 | 798 | 11800 | 10100 | 12868 |
| TORONTO (STP) | 0004 | 0.03 | - | - | - | - | - | 8420 | 0 |

KEY: < Less than detection limit

- No data

NICKEL

| LOCATION | STATION | IW | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|--------|----|-------|----|----|----------|------|-----|
| TORONTO (STP) | 0008 | 0.06 | 4 | 4.0 | 7 | 8 | 10 | 23 | 46 |
| TORONTO (STP) | 0005 | - | 3 | 5.0 | 4 | 7 | 11 | 20 | 43 |
| TORONTO (STP) | 0001 | - | 3 | 4.0 | 5 | 4 | 7 | 17 | 23 |
| TORONTO (STP) | 0003 | - | 3 | 4.0 | 4 | 3 | 7 | 14 | 21 |
| TORONTO (STP) | 0012 | 0.07 | 4 | 4.0 | 3 | 5 | 15 | 19 | 44 |
| TORONTO (STP) | 0006 | 0.14 | 3 | 4.0 | 4 | 4 | 8 | 16 | 35 |
| TORONTO (STP) | 0010 | 0.13 | 4 | 4.0 | 4 | 5 | 14 | 30 | 56 |
| TORONTO (STP) | 0011 | 0.07 | 4 | 4.0 | 4 | 4 | 18 | 13 | 43 |
| TORONTO (STP) | 0007 | 0.12 | 3 | 4.0 | 4 | 3 | 7 | 13 | 31 |
| TORONTO (STP) | 0002 | < 0.05 | 4 | 3.0 | 3 | 5 | 17 | 15 | 32 |
| TORONTO (STP) | 0009 | < 0.05 | 4 | < 2.0 | 5 | 5 | 551 | 18 | 582 |
| TORONTO (STP) | 0004 | < 0.05 | - | - | - | - | - | 12 | 12 |

KEY: < Less than detection limit

- No data

IRON

| LOCATION | STATION | 1W | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|-------|-------|------|-------|------|----------|--------|-------|
| TORONTO (STP) | 0008 | 4.65 | 129.0 | 1040 | 311.0 | 5320 | 12300 | 19900 | 18490 |
| TORONTO (STP) | 0005 | - | 12.9 | 2890 | 73.0 | 5780 | 12200 | 22800 | 20956 |
| TORONTO (STP) | 0001 | - | 23.6 | 659 | 83.0 | 3300 | 10147 | 16666 | 14213 |
| TORONTO (STP) | 0003 | - | 23.1 | 1050 | 87.1 | 3000 | 11300 | 14200 | 15460 |
| TORONTO (STP) | 0012 | 7.23 | 46.6 | 1230 | 210.0 | 2870 | 12000 | 16300 | 16547 |
| TORONTO (STP) | 0006 | 17.40 | 24.5 | 616 | 99.8 | 4100 | 10200 | 187600 | 15040 |
| TORONTO (STP) | 0010 | 14.00 | 50.7 | 877 | 319.0 | 3550 | 9790 | 15900 | 14105 |
| TORONTO (STP) | 0011 | 2.79 | 7.5 | 395 | 193.0 | 2920 | 11200 | 14100 | 15551 |
| TORONTO (STP) | 0007 | 38.40 | 25.9 | 470 | 98.6 | 2930 | 9090 | 16500 | 12615 |
| TORONTO (STP) | 0002 | 0.59 | 4.8 | 780 | 599.0 | 4740 | 17100 | 16600 | 23224 |
| TORONTO (STP) | 0009 | 1.22 | 14.1 | 420 | 298.0 | 3390 | 12900 | 16000 | 17479 |
| TORONTO (STP) | 0004 | 4.39 | - | - | - | - | - | 15300 | 0 |

KEY: < Less than detection limit

- No data

MANGANESE

| LOCATION | STATION | 1W | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|-------|-------|-------|------|------|----------|------|-------|
| TORONTO (STP) | 0008 | 0.075 | 53.7 | 63.7 | 74.9 | 25.1 | 83.2 | 295 | 574.1 |
| TORONTO (STP) | 0005 | - | 16.9 | 71.8 | 36.4 | 34.5 | 110.0 | 233 | 468.1 |
| TORONTO (STP) | 0001 | - | 19.1 | 49.8 | 35.3 | 38.2 | 131.0 | 370 | 273.4 |
| TORONTO (STP) | 0003 | - | 17.9 | 57.0 | 35.6 | 31.5 | 171.0 | 241 | 313.0 |
| TORONTO (STP) | 0012 | 0.900 | 43.5 | 75.4 | 35.8 | 20.0 | 117.0 | 286 | 610.3 |
| TORONTO (STP) | 0006 | 0.390 | 21.6 | 59.3 | 50.8 | 48.3 | 102.0 | 320 | 553.7 |
| TORONTO (STP) | 0010 | 0.310 | 21.8 | 41.7 | 55.4 | 25.7 | 100.0 | 240 | 482.5 |
| TORONTO (STP) | 0011 | 1.220 | 48.8 | 65.3 | 55.3 | 43.7 | 111.0 | 299 | 589.5 |
| TORONTO (STP) | 0007 | 2.020 | 30.2 | 58.9 | 54.6 | 46.0 | 110.0 | 356 | 609.7 |
| TORONTO (STP) | 0002 | 0.910 | 106.0 | 102.0 | 44.6 | 29.8 | 116.0 | 352 | 398.4 |
| TORONTO (STP) | 0009 | 1.110 | 68.6 | 67.3 | 55.7 | 34.5 | 116.0 | 310 | 592.0 |
| TORONTO (STP) | 0004 | 2.530 | - | - | - | - | - | 572 | 572.0 |

KEY: < Less than detection limit

- No data

CHROMIUM

| LOCATION | STATION | 1W | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|--------|-----|-------|------|------|----------|-------|-------|
| TORONTO (STP) | 0008 | < 0.01 | 1.1 | < 0.4 | 65.5 | 13.1 | 27.6 | 111.0 | 107.3 |
| TORONTO (STP) | 0005 | - | 0.3 | 1.4 | 57.6 | 20.3 | 65.5 | 152.0 | 145.1 |
| TORONTO (STP) | 0001 | - | 1.0 | 1.0 | 27.6 | 10.3 | 32.3 | 88.0 | 72.2 |
| TORONTO (STP) | 0003 | - | 0.8 | 1.3 | 36.2 | 8.2 | 26.0 | 75.0 | 72.5 |
| TORONTO (STP) | 0012 | < 0.01 | 0.5 | 0.7 | 24.7 | 6.5 | 26.6 | 70.9 | 59.0 |
| TORONTO (STP) | 0006 | 0.06 | 0.5 | 1.1 | 38.9 | 8.3 | 23.8 | 92.4 | 72.4 |
| TORONTO (STP) | 0010 | 0.06 | 1.1 | < 0.4 | 43.1 | 11.6 | 16.0 | 64.3 | 72.2 |
| TORONTO (STP) | 0011 | < 0.01 | 0.6 | < 0.4 | 10.6 | 0.9 | 14.4 | 19.8 | 26.9 |
| TORONTO (STP) | 0007 | 0.08 | 0.6 | 1.1 | 13.2 | 2.6 | 17.6 | 54.3 | 35.1 |
| TORONTO (STP) | 0002 | < 0.01 | 0.6 | 0.6 | 6.1 | 1.3 | 17.6 | 11.2 | 26.2 |
| TORONTO (STP) | 0009 | < 0.01 | 0.5 | < 0.4 | 12.2 | 2.2 | 17.5 | 24.4 | 32.4 |
| TORONTO (STP) | 0004 | < 0.01 | - | - | - | - | - | 26.5 | 0.0 |

KEY: < Less than detection limit

- No data

COPPER

| LOCATION | STATION | 1W | F1 | F2 | F3 | F4 | RESIDUAL | BULK | SUM |
|---------------|---------|---------|-------|-------|-------|------|----------|-------|-------|
| TORONTO (STP) | 0008 | 0.022 | 0.9 | < 0.3 | 175.0 | 70.2 | 22.7 | 309.0 | 268.8 |
| TORONTO (STP) | 0005 | - | < 0.3 | < 0.3 | 64.4 | 58.7 | 19.9 | 159.0 | 143.0 |
| TORONTO (STP) | 0001 | - | < 0.3 | < 0.3 | 35.4 | 25.2 | 6.7 | 64.0 | 67.3 |
| TORONTO (STP) | 0003 | - | < 0.3 | < 0.3 | 25.1 | 21.3 | 4.9 | 49.7 | 51.3 |
| TORONTO (STP) | 0012 | < 0.008 | < 0.3 | < 0.3 | 20.0 | 19.8 | 10.4 | 57.0 | 50.2 |
| TORONTO (STP) | 0006 | 0.053 | < 0.3 | < 0.3 | 25.1 | 25.4 | 6.3 | 59.4 | 56.8 |
| TORONTO (STP) | 0010 | 0.070 | < 0.3 | < 0.3 | 37.9 | 18.5 | 4.3 | 51.1 | 60.7 |
| TORONTO (STP) | 0011 | < 0.008 | < 0.3 | < 0.3 | 12.2 | 12.8 | 4.2 | 21.1 | 29.2 |
| TORONTO (STP) | 0007 | 0.084 | < 0.3 | < 0.3 | 7.6 | 10.5 | 2.3 | 24.3 | 20.4 |
| TORONTO (STP) | 0002 | < 0.008 | < 0.3 | < 0.3 | 11.7 | 14.8 | 7.6 | 21.1 | 34.1 |
| TORONTO (STP) | 0009 | 0.030 | < 0.3 | < 0.3 | 14.4 | 10.9 | 5.4 | 32.4 | 30.7 |
| TORONTO (STP) | 0004 | < 0.008 | - | - | - | - | - | 22.9 | 0.0 |

KEY: < Less than detection limit

- No data

TABLE 8: In-Place Pollutants Program
Toronto Harbour Main STP, 1987
Sediment - PCBs and Pesticides

(JULY-AUGUST) Units: ng/g Dry Weight

| Station | Aldrin | A-BHC Hexa- chloro- cyclo- hexane | B-BHC Hexa- chloro- cyclo- hexane | G-BHC Hexa- chloro- cyclo- hexane | A-Chlor- dane | G-Chlor- dane | Dieldrin | DMDT | Endo- methoxy- chlor | Endo- Sulfan I | Endrin Sulfan II | Endo- sulfan- sulphate | Hepta- chlor- epoxide | Hepta- chlor | Mirex | Oxy- chlor- dane | OP-DDT | PCB (total) | PP-DDD | PP-DDE | PP-DDT | Hexa- chloro- benzene | Toxaphene | Octa- chloro- styrene |
|---------|--------|---|---|---|------------------|------------------|----------|------|----------------------------|----------------------|------------------------|------------------------------|-----------------------------|-----------------|-------|------------------------|--------|----------------|--------|--------|--------|-----------------------------|-----------|-----------------------------|
| 0008 | < 1 | < 1 | < 1 | 2 | 40 | 48 | 100 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | 470 P40 | 15 | 3 | 5 | 6 | < 200 | 5 |
| 0005 | < 1 | < 1 | < 1 | < 1 | < 2 | 3 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | 36 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0001 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0003 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0012 | < 1 | < 1 | < 1 | < 1 | 1 | 1 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0006 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0010 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 5 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0011 | < 1 | < 1 | < 1 | < 1 | 1 | 1 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0007 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 3 | < 1 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0002 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0009 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |
| 0004 | < 1 | < 1 | < 1 | < 1 | < 2 | < 2 | < 2 | < 3 | < 2 | < 4 | < 4 | < 4 | < 1 | < 1 | < 5 | < 2 | < 5 | < 20 | < 5 | < 1 | < 5 | < 1 | < 200 | < 1 |

< Less than detection limit

P40 PCB resembled mixture of aroclor 1254 and 1260

TABLE 9: In-Place Pollutants Program
1987 Toronto STP Study (JULY)
Sediment - PAHs
Units: ug/g Dry Weight

| Station | Phen- anthrene | Anth- racene | Fluor- anthrene | Fluorene | Pyrene | Benzo- (a) anth- racene | Chrysene | Benzo- (k) fluor- anthrene | Benzo- (b)- fluorene | Benzo- (a)- pyrene | Benzo- (g,h,i)- perylene | Dibenzo- (a,h)- anth- racene | Indeno- (1,2,3-cd)- pyrene | Naphth- alene | Acenaph- thylene | Acenaph- thene |
|---------|-------------------|-----------------|--------------------|----------|--------|-------------------------------|----------|----------------------------------|----------------------------|--------------------------|--------------------------------|---------------------------------------|----------------------------------|------------------|---------------------|-------------------|
| 0008 | 14.00 | 0.01 <T | 0.03 | 14.00 | 9.50 | 2.80 | 3.30 | 2.30 | 2.30 | 0.44 | 1.40 | 0.22 | 1.20 | 0.54 | 0.04 <T | 0.04 <T |
| 0005 | 20.00 | 5.50 | 16.00 | 3.50 | 13.00 | 4.90 | 6.70 | 4.80 | 4.80 | 4.30 | 2.30 | 0.44 | 2.10 | 2.60 | 0.13 | 2.30 |
| 0001 | 11.00 | 2.60 | 11.00 | 1.40 | 9.20 | 3.60 | 4.80 | 3.50 | 3.50 | 3.00 | 1.60 | 0.29 | 1.50 | 0.48 | 0.22 | 0.70 |
| 0003 | 0.53 | 0.10 | 0.41 | 0.12 | 0.49 | 0.20 | 0.12 | 0.10 | 0.10 | 0.06 | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.07 |
| 0012 | 0.31 | 0.09 | 0.44 | < 0.03 | 0.39 | 0.18 | 0.28 | < 0.02 | 0.21 | 0.18 | 0.10 | 0.07 | 0.12 | 0.04 <T | < 0.05 | < 0.04 |
| 0006 | 0.31 | 0.05 | 0.39 | 0.09 | 0.40 | 0.20 | 0.13 | 0.15 | 0.15 | 0.09 | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.06 |
| 0010 | 0.07 <T | 0.01 <T | 0.06 | 0.04 <T | 0.07 | 0.03 | 0.02 <T | 0.02 <T | 0.06 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T |
| 0011 | < 0.07 | < 0.01 | 0.06 | 0.04 | 0.07 | 0.03 | 0.04 | < 0.02 | < 0.06 | 0.05 | 0.04 | 0.04 | 0.05 | 0.04 <T | < 0.05 | < 0.04 |
| 0007 | 0.23 | 0.04 | 0.31 | 0.07 | 0.29 | 0.14 | 0.09 | 0.11 | 0.11 | 0.06 | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.05 |
| 0002 | 1.10 | 0.21 | 1.20 | 0.15 | 1.30 | 0.46 | 0.30 | 0.27 | 0.27 | 0.24 | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.04 <T | 0.10 |
| 0009 | 0.21 | 0.05 | 0.36 | 0.04 <T | 0.31 | 0.18 | 0.19 | 0.19 | 0.19 | 0.17 | 0.15 | 0.04 <T | 0.15 | 0.04 <T | 0.04 <T | 0.04 <T |
| 0004 | 1.50 | 0.34 | 1.20 | 0.28 | 0.98 | 0.49 | 0.30 | 0.28 | 0.28 | 0.22 | 0.04 <T | 0.04 <T | 0.04 <T | 0.19 | 0.09 | 0.17 |

<T Tentative value, for information only

TABLE 10 In-Place Pollutants Program
Sediment - Organics
Toronto Main STP 1987

(JULY-AUGUST)

Units: ng/g Dry Weight

| Station | Hexa- chloro- ethane | 1,3,5 Tri- chloro- benzene | 1,2,4 Tri- chloro- benzene | Hexa- chloro- buta- diene | 1,2,3 Tri- chloro- benzene | 2,4,5 Tri- chloro- toluene | 2,3,6 Tri- chloro- toluene | 1,2,3,5 Tetra- chloro- benzene | 1,2,4,5 Tetra- chloro- benzene | 2,6,a Tri- chloro- toluene | 1,2,3,4 Tetra- chloro- toluene | Penta- chloro- benzene |
|---------|----------------------------|-------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|---|---|-------------------------------------|---|------------------------------|
| 0008 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0005 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0001 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0003 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0012 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0006 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0010 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0011 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0007 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0002 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0009 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0004 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |

(OCTOBER)

Units: ng/g dry weight

| Station | Hexa- chloro- ethane | 1,3,5 Trichloro- benzene | 1,2,4 Trichloro- benzene | Hexa- chloro- butadiene | 1,2,3 Trichloro- benzene | 2,4,5 Trichloro- toluene | 2,3,6 Trichloro- toluene | 1,2,3,5 Tetrachloro- benzene | 1,2,4,5 Tetrachloro- benzene | 2,6,a Trichloro- toluene | Tetra- chloro- benzene | Penta- chloro- benzene |
|---------|----------------------------|--------------------------------|--------------------------------|-------------------------------|--------------------------------|--------------------------------|--------------------------------|------------------------------------|------------------------------------|--------------------------------|------------------------------|------------------------------|
| 0008 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0005 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0001 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0003 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0012 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 0 | < 0 | < 1 | < 1 |
| 0006 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0010 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 0 | < 0 | < 1 | < 1 |
| 0011 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 0 | < 0 | < 1 | < 1 |
| 0007 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0002 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |
| 0009 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 0 | < 0 | < 1 | < 1 |
| 0004 | < 1 | < 2 | < 2 | < 1 | < 2 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 | < 1 |

< Lower than detection limit

| Station | Biota | Wet weight | Dry Weight | Copper | Chromium | Mercury | Cadmium | Iron | Arsenic | Manganese | Aluminum | Nickel |
|---------|--------------|------------|------------|--------|----------|---------|---------|------|---------|-----------|----------|--------|
| 0008 | Oligochaetes | 5.8 | 1.9296 | 16.89 | 5.99 | 0.052 | 0.365 | 876 | 0.47 | 14.18 | 324 | 1.66 |
| 0005 | Oligochaetes | 4.0 | 1.9322 | 7.29 | 4.53 | 0.039 | 0.225 | 644 | 0.48 | 7.14 | 166 | 1.37 |
| 0001 | Oligochaetes | 6.8 | 2.0320 | 3.65 | 1.67 | 0.028 | 0.142 | 314 | 0.47 | 5.11 | 91 | 0.78 |
| 0003 | Oligochaetes | 6.0 | 1.9742 | 7.09 | 4.16 | 0.037 | 0.227 | 616 | 0.71 | 11.98 | 236 | 1.45 |
| 0012 | Oligochaetes | 4.0 | 1.7425 | 12.67 | 1.22 | 0.058 | 0.301 | 532 | 1.93 | 11.09 | 194 | 0.78 |
| 0012 | Chironamids | 2.8 | 1.9813 | 8.18 | 4.79 | 0.062 | 0.273 | 997 | 0.36 | 14.40 | 305 | 1.29 |
| 0006 | Oligochaetes | 5.7 | 2.0481 | 4.20 | 1.95 | 0.029 | 0.117 | 303 | 0.54 | 5.38 | 80 | 0.82 |
| 0010 | Oligochaetes | 2.5 | 1.5713 | 7.07 | 4.76 | 0.040 | 0.249 | 614 | 3.40 | 10.13 | 186 | 1.39 |
| 0011 | Oligochaetes | 1.6 | 0.9092 | 6.36 | 2.15 | 0.051 | 0.231 | 441 | 4.13 | 11.24 | 198 | 0.79 |
| 0007 | Oligochaetes | 5.3 | 2.3223 | 7.01 | 3.21 | 0.035 | 0.192 | 727 | 0.86 | 16.66 | 288 | 1.63 |
| 0002 | Oligochaetes | 4.2 | 2.2185 | 6.76 | 3.23 | 0.031 | 0.171 | 777 | 0.81 | 16.73 | 361 | 1.44 |
| 0009 | Oligochaetes | 4.0 | 2.1413 | 6.51 | 1.32 | 0.032 | 0.243 | 486 | 0.78 | 15.24 | 225 | 1.17 |
| 0004 | Oligochaetes | 3.5 | 2.0125 | 9.66 | 3.09 | 0.039 | 0.370 | 780 | 1.77 | 24.86 | 385 | 1.71 |

| Station | Biota | Wet weight | Dry Weight | Copper | Chromium | Mercury | Cadmium | Iron | Arsenic | Manganese | Aluminum | Nickel |
|---------|--------------|------------|------------|--------|----------|---------|---------|------|---------|-----------|----------|--------|
| 0008 | Oligochaetes | 5.8 | 1.9296 | 16.89 | 5.99 | 0.052 | 0.365 | 876 | 0.47 | 14.18 | 324 | 1.66 |
| 0005 | Oligochaetes | 4.0 | 1.9322 | 7.29 | 4.53 | 0.039 | 0.225 | 644 | 0.48 | 7.14 | 166 | 1.37 |
| 0001 | Oligochaetes | 6.8 | 2.0320 | 3.65 | 1.67 | 0.028 | 0.142 | 314 | 0.47 | 5.11 | 91 | 0.78 |
| 0003 | Oligochaetes | 6.0 | 1.9742 | 7.09 | 4.16 | 0.037 | 0.227 | 616 | 0.71 | 11.98 | 236 | 1.45 |
| 0012 | Oligochaetes | 4.0 | 1.7425 | 12.67 | 1.22 | 0.058 | 0.301 | 532 | 1.93 | 11.09 | 194 | 0.78 |
| 0012 | Chironamids | 2.8 | 1.9813 | 8.18 | 4.79 | 0.062 | 0.273 | 997 | 0.36 | 14.40 | 305 | 1.29 |
| 0006 | Oligochaetes | 5.7 | 2.0481 | 4.20 | 1.95 | 0.029 | 0.117 | 303 | 0.54 | 5.38 | 80 | 0.82 |
| 0010 | Oligochaetes | 2.5 | 1.5713 | 7.07 | 4.76 | 0.040 | 0.249 | 614 | 3.40 | 10.13 | 186 | 1.39 |
| 0011 | Oligochaetes | 1.6 | 0.9092 | 6.36 | 2.15 | 0.051 | 0.231 | 441 | 4.13 | 11.24 | 198 | 0.79 |
| 0007 | Oligochaetes | 5.3 | 2.3223 | 7.01 | 3.21 | 0.035 | 0.192 | 727 | 0.86 | 16.66 | 288 | 1.63 |
| 0002 | Oligochaetes | 4.2 | 2.2185 | 6.76 | 3.23 | 0.031 | 0.171 | 777 | 0.81 | 16.73 | 361 | 1.44 |
| 0009 | Oligochaetes | 4.0 | 2.1413 | 6.51 | 1.32 | 0.032 | 0.243 | 486 | 0.78 | 15.24 | 225 | 1.17 |
| 0004 | Oligochaetes | 3.5 | 2.0125 | 9.66 | 3.09 | 0.039 | 0.370 | 780 | 1.77 | 24.86 | 385 | 1.71 |

**TABLE 12. Benthic Invertebrates - Tissue-Sediment Concentration Ratios
Toronto Main STP, 1987.**

| Station No. | Copper | Chromium | Mercury | Cadmium | Iron | Lead |
|-------------|--------|----------|---------|---------|------|------|
| 0008 | 0.31 | 0.22 | 0.004 | 0.32 | 0.19 | 0.23 |
| 0005 | 1.07 | 0.61 | 2.50 | 1.81 | 0.28 | 0.66 |
| 0001 | 0.60 | 0.30 | 1.98 | 1.18 | 0.15 | 0.20 |
| 0003 | 1.45 | 0.70 | 1.98 | 1.74 | 0.33 | 0.98 |
| 0012 | 1.61 | 0.08 | 2.63 | 0.95 | 0.19 | 1.51 |
| 0006 | 0.82 | 0.26 | 0.39 | 0.66 | 0.14 | 0.58 |
| 0010 | 2.39 | 1.16 | 5.14 | 3.92 | 0.41 | 2.22 |
| 0011 | 1.44 | 0.36 | 6.51 | 1.88 | 0.18 | 0.98 |
| 0007 | 1.73 | 0.59 | 2.51 | 2.06 | 0.30 | 0.91 |
| 0002 | 3.11 | 1.47 | 4.95 | 3.34 | 0.51 | 1.46 |
| 0009 | 1.14 | 0.16 | 2.92 | 2.08 | 0.16 | 0.44 |
| 0004 | 17.26 | 2.22 | 25.87 | 12.21 | 1.00 | 5.38 |

| Station No. | Zinc | Arsenic | Manganese | Aluminum | Nickel |
|-------------|-------|---------|-----------|----------|--------|
| 0008 | 0.38 | 0.35 | 0.19 | 0.14 | 0.29 |
| 0005 | 1.54 | 1.39 | 0.24 | 0.25 | 0.87 |
| 0001 | 1.37 | 1.50 | 0.14 | 0.11 | 0.50 |
| 0003 | 2.12 | 2.69 | 0.35 | 0.27 | 1.00 |
| 0012 | 4.04 | 4.27 | 2.36 | 0.13 | 0.25 |
| 0006 | 1.41 | 2.13 | 0.14 | 0.07 | 0.46 |
| 0010 | 4.33 | 23.77 | 0.40 | 0.32 | 1.50 |
| 0011 | 2.84 | 12.77 | 0.40 | 0.32 | 1.50 |
| 0007 | 2.63 | 3.29 | 0.36 | 0.21 | 0.93 |
| 0002 | 3.86 | 4.39 | 0.60 | 0.55 | 1.41 |
| 0009 | 4.04 | 1.17 | 0.24 | 0.11 | 0.38 |
| 0004 | 30.92 | 10.60 | 1.21 | 1.05 | 3.18 |

Sediment concentrations used in the calculations were on a dry weight (ug/g) basis. Biota values used were wet weight converted to dry weight and corrected for gut contents according to the formula in Persaud *et al* (1987). Gut corrected tissue concentrations were computed according to the formula:

$$C_{ct} = C_{org} - (C_{sed} \times K_{ash}) \times (1 - K_{ash})^{-1}$$

where C_{ct} = gut corrected tissue concentration; C_{org} = organism (dry weight) contaminant concentration; C_{sed} = bulk sediment concentration and; K_{ash} = residue after ashing organism at 500° C (as a percentage).

Tissue-sediment concentration ratios were computed according to the formula:

$$\text{Ratio} = C_{ct} / C_{sed}$$

TABLE 13: In-Place Pollutants Program

Toronto Main STP, 1987

Benthic Invertebrates - PCBs and Pesticides

Units: ug/g

| Station | Biota | Sample | Aldrin | A-BHC | B-BHC | A- | G- | Diel- | DWDT | Endo- | Endo- | Endrin | ENDO- | Hepta- | Hepta- | Mirex | Oxychlor- | OP-DDT | PCB | PP-DDD | PP-DDE | PP-DDT | Hexa- | % | % | d-BHC |
|---------|--------------|---------|---------|---------|---------|---------|---------|---------|----------|---------|---------|---------|---------|---------|---------|---------|-----------|---------|--------|---------|---------|---------|---------|-------|------|---------|
| | | Wet Wt. | | | | Chlor- | Chlor- | drin | Meth- | Sulfan | Sulfan | | S04 | chlor- | chlor | | dane | | | | | | chloro | Lipid | ASH | |
| | | g | | | | dane | dane | | oxychlor | I | II | | | epoxide | | | | | | | | | ethane | | | |
| 0008 | Oligochaetes | 4.409 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.234 | 3.47 | < 0.001 |
| 0005 | Oligochaetes | 4.212 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.418 | 1.85 | < 0.001 |
| 0001 | Oligochaetes | 6.240 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | 0.008 | NA | < 0.001 | 0.16 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.586 | 1.85 | 0.001 |
| 0003 | Oligochaetes | 4.326 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | 0.016 | NA | < 0.001 | < 0.01 | 0.009 | 0.004 | < 0.001 | < 0.001 | 0.425 | 3.39 | < 0.001 |
| 0012 | Oligochaetes | 0.653 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.919 | 2.60 | < 0.001 |
| 0012 | Chironamids | 3.830 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.389 | 3.73 | < 0.001 |
| 0006 | Oligochaetes | 4.571 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | 0.18 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.486 | 1.76 | < 0.001 |
| 0010 | Oligochaetes | 3.848 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | 0.40 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.460 | 3.46 | < 0.001 |
| 0011 | Oligochaetes | 1.919 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 1.040 | 2.38 | < 0.001 |
| 0011 | Chironamids | 1.678 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.757 | 4.48 | < 0.001 |
| 0007 | Oligochaetes | 4.504 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | 0.005 | < 0.001 | < 0.001 | < 0.001 | 0.391 | 4.07 | < 0.001 |
| 0002 | Oligochaetes | 3.932 | < 0.001 | < 0.001 | < 0.001 | 0.003 | 0.003 | < 0.001 | < 0.001 | 0.003 | 0.007 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | 0.29 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.961 | 3.52 | 0.003 |
| 0009 | Oligochaetes | 3.836 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | 0.77 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | 0.287 | 4.01 | < 0.001 |

< Lower than detection limit

NA Not Available

TABLE 14: In-Place Pollutants Program
1987 Toronto Main STP
Benthic Invertebrate - PAHs
Unit: ug/g

| Station | Biota | Phen- an- threne | Flour- an- thene | Pyrene | Benzo- (a)- Anthra- cene | Chry- sene | Benzo (e)- Pyrene | Benzofluoranthene (b) | fluoranthene (j) | (k) | Pery- lene | Benzo- (a)- Pyrene | Benzo- (ghi)- pery- lene | Dibenz- (a,h)- Anth- rene | Indeno- (123-cd) Pyrene | Anthra- threne | Coro- nene | Dimethyl- benz(a) Anthra- cene |
|---------|--------------|------------------------|------------------------|---------|-----------------------------------|---------------|-------------------------|--------------------------|---------------------|---------|---------------|--------------------------|-----------------------------------|------------------------------------|-------------------------------|-------------------|---------------|---|
| 0008 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0005 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0001 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0003 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0012 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0012 | Chironamids | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0006 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0010 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0011 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0011 | Chironamids | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0007 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0002 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0009 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |
| 0004 | Oligochaetes | < 0.002 | < 0.002 | < 0.003 | < 0.003 | < 0.003 | < 0.005 | < 0.005 | NA | < 0.005 | < 0.000 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | NA | NA | NA |

< Lower than detection limit
NA Not available

TABLE 15: In-Place Pollutants Program

Benthic Invertebrates - Chlorinated Aromatics

Toronto Main STP, 1987

Units: ug/g

| Station | Biota | Hexa- 1,3,5 | 1,2,4 | Hexa- 1,2,3 | 2,4,5 | 2,3,6 | 1,2,3,5 | 1,2,4,5 | 2,6a |
|---------|--------------|--|---------|-------------|---------|---------|---------|---------|---------|
| | | chloro- Tri- Tri- chloro- Tri- Tri- Tri- Tetra- Tetra- Tri- | | | | | | | |
| | | ethane chloro- chloro- buta- chloro- chloro- chloro- chloro- chloro- chloro- | | | | | | | |
| | | benzene benzene diene benzene toluene toluene benzene benzene toluene | | | | | | | |
| 0008 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0005 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0001 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0003 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0012 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0012 | CHIRONOMIDS | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0006 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0010 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0011 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0011 | CHIRONOMIDS | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0007 | OLIGOCHAETES | < 0.001 | 0.002 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0002 | OLIGOCHAETES | < 0.001 | 0.002 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0009 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |
| 0004 | OLIGOCHAETES | < 0.001 | < 0.010 | < 0.010 | < 0.001 | < 0.005 | NA | NA | < 0.001 |

< Lower than detection limit

TABLE 16: In-Place Pollutants Program

1987 Toronto Main STP

Sculpins - Metals

Units: ug/g

| Station | Species | Age (yrs) | Alum- inum | Arsenic | Cadmium | Chromium | Copper | Iron | Lead | Mang- anese | mercury | Nickel | Zinc |
|---------------|-------------------|-----------|------------|---------|---------|----------|--------|------|------|-------------|---------|--------|-------|
| TRAP-LSP | C. Bairdi | 2-3 | 25.0 | 0.89 | 0.880 | 0.75 | 6.02 | 37.0 | 1.51 | 2.20 | 0.038 | 0.63 | 53.80 |
| TRAP-LSP | C. Bairdi | 3-4 | 12.0 | 1.53 | 0.026 | 0.61 | 3.25 | 19.0 | 0.58 | 1.40 | 0.052 | 0.32 | 33.30 |
| SCUBA-LSP | C. Cognatus | 3-4 | 37.0 | 0.54 | 0.036 | 0.66 | 5.13 | 64.0 | 1.06 | 2.30 | 0.051 | 0.52 | 23.20 |
| SCUBA-LSP | C. Bairdi | 4-5 | 15.0 | 0.47 | 0.028 | 0.55 | 3.55 | 36.0 | 0.36 | 1.30 | 0.042 | 0.37 | 25.70 |
| TRAP A.B. BAY | C. Cognatus | 1 | 19.0 | 0.44 | 0.030 | 0.80 | 6.49 | 42.0 | 1.24 | 2.10 | 0.057 | 0.62 | 29.90 |
| A.B. BAY | C. Cognatus | 2 | 28.0 | 0.43 | 0.034 | 0.73 | 6.57 | 50.0 | 0.97 | 2.20 | 0.040 | 0.46 | 30.40 |
| A.B. BAY | C. Bairdi | 2-3 | 20.0 | 0.63 | 0.046 | 0.73 | 5.04 | 40.0 | 0.64 | 2.60 | 0.070 | 0.40 | 34.90 |
| A.B. BAY | C. Cog.-C. Bairdi | 4-5 | 21.0 | 0.31 | 0.047 | 0.65 | 5.46 | 46.0 | 0.65 | 1.60 | 0.112 | 0.36 | 31.70 |
| A.B. BAY | C. Bairdi-Hybrid | 5 | 29.0 | 1.45 | 0.050 | 1.08 | 7.24 | 52.0 | 2.26 | 2.40 | 0.081 | 0.67 | 45.20 |
| 0005 | C. Bairdi | 3-4 | 20.0 | 0.46 | 0.042 | 0.67 | 5.85 | 42.0 | 0.32 | 1.30 | 0.125 | 0.17 | 26.10 |
| 0005 | C. Bairdi | 4-5 | 16.0 | 0.53 | 0.030 | 0.72 | 4.47 | 26.0 | 0.28 | 0.80 | 0.138 | 0.51 | 29.60 |
| 0005 | C. Bairdi | 4-5 | 15.0 | 0.65 | 0.024 | 0.74 | 4.38 | 26.0 | 0.40 | 1.30 | 0.166 | 0.36 | 31.60 |
| 0001 | C. Cognatus | 2-3 | 31.0 | 0.88 | 0.046 | 0.73 | 8.09 | 55.0 | 0.35 | 3.10 | 0.049 | 0.33 | 22.10 |
| 0001 | C. Cognatus | 3 | 24.0 | 0.47 | 0.024 | 0.56 | 5.25 | 39.0 | 0.29 | 1.40 | 0.054 | 0.35 | 18.90 |
| 0001 | C. Bairdi | 4-5 | 18.0 | 0.65 | 0.041 | 0.57 | 5.96 | 36.0 | 0.41 | 1.20 | 0.118 | 0.32 | 26.00 |
| 0003 | C. Cognatus | 3-4 | 29.0 | 0.32 | 0.056 | 0.91 | 6.28 | 85.0 | 1.55 | 2.60 | 0.062 | 0.35 | 20.20 |
| 0006 | C. Bairdi | 3-4 | 11.0 | 0.33 | 0.051 | 0.58 | 5.03 | 31.0 | 0.70 | 1.10 | 0.102 | 0.54 | 28.20 |
| 0006 | Hybrid | 3-4 | 27.0 | 0.38 | 0.076 | 0.88 | 5.66 | 66.0 | 0.59 | 3.30 | 0.078 | 0.47 | 25.40 |
| 0006 | C. Cognatus | 4-5 | 18.0 | 0.62 | 0.047 | 0.99 | 8.49 | 22.0 | 0.58 | 5.10 | 0.079 | 0.67 | 18.60 |
| 0006 | C. Cognatus | 4-5 | 12.0 | 0.36 | 0.037 | 0.66 | 5.49 | 19.0 | 0.48 | 4.10 | 0.094 | 0.38 | 18.80 |
| 0007 | C. Cognatus | 3-4 | 10.0 | 0.28 | 0.015 | 0.53 | 4.05 | 26.0 | 0.22 | 1.50 | 0.047 | 0.40 | 18.60 |
| 0002 | C. Cognatus | 2-3 | 31.0 | 0.42 | 0.046 | 0.70 | 5.82 | 51.0 | 0.46 | 2.90 | 0.037 | 0.47 | 19.80 |
| 0002 | C. Cognatus | 3-4 | 27.0 | 0.34 | 0.026 | 0.60 | 3.77 | 48.0 | 0.37 | 2.10 | 0.050 | 0.32 | 18.50 |
| 0002 | C. Cognatus | 4-5 | 48.0 | 0.33 | 0.048 | 0.77 | 6.00 | 86.0 | 0.39 | 2.70 | 0.056 | 0.47 | 22.30 |
| 0004 | C. Cognatus | 3-4 | 36.0 | 0.24 | 0.042 | 0.75 | 5.00 | 61.0 | 0.37 | 2.40 | 0.049 | 0.52 | 18.00 |

TABLE 17: In-Place Pollutants Program
1987 Toronto Main STP
Sculpins - PCBs and Pesticides
Units: ug/g

| Station | Species | Aldrin | A-BHC | B-BHC | A-Chlor-dane | G-Chlor-dane | Dieldrin | DMDT methoxy-chlor | Endo-Sulfan I | Endo-Sulfan II | Endrin | Endo-sulfan sulphate | Hepta-chlor-epoxide | Hepta-chlor | Mirex | Oxy-chlor-dane | op-DDT | PCB (total) | pp-DDO | pp-DDE | pp-DDT | % Lipid | % Ash |
|----------|--------------|---------|---------|---------|--------------|--------------|----------|-----------------------|------------------|-------------------|---------|-------------------------|---------------------|-------------|---------|----------------|---------|----------------|---------|---------|---------|---------|-------|
| A.B. BAY | Cognatus | < 0.001 | 0.007 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.007 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.048 | < 0.001 | 2.220 | 3.73 |
| A.B. BAY | Bairdi | < 0.001 | 0.005 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.005 | < 0.001 | 3.510 | 3.22 |
| A.B. BAY | Cog.-C. Bair | < 0.001 | 0.008 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.008 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | 0.24 | < 0.001 | 0.029 | < 0.001 | 2.050 | 4.47 |
| A.B. BAY | Cog.-C. Bair | < 0.001 | 0.004 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.004 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | 0.635 | 3.63 |
| A.B. BAY | Bairdi HYB | < 0.001 | < 0.000 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.018 | < 0.001 | 1.880 | 4.04 |
| 0005 | Bairdi | < 0.001 | 0.003 | < 0.001 | < 0.001 | < 0.001 | 0.014 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.003 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.022 | < 0.001 | 4.310 | 3.54 |
| 0005 | Bairdi | < 0.001 | 0.004 | < 0.001 | < 0.001 | < 0.001 | 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.004 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.031 | < 0.001 | 2.720 | 5.03 |
| 0001 | Cognatus | < 0.001 | 0.007 | < 0.001 | < 0.001 | < 0.001 | 0.017 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.007 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.069 | < 0.001 | 5.050 | 3.95 |
| 0001 | Cognatus | < 0.001 | 0.005 | < 0.001 | < 0.001 | < 0.001 | 0.008 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.005 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.020 | < 0.001 | 4.180 | 4.39 |
| 0001 | Bairdi | < 0.001 | 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.027 | < 0.001 | 2.530 | 3.48 |
| 0001 | Bairdi | < 0.001 | 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.001 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.024 | < 0.001 | 2.650 | 3.33 |
| 0003 | Cognatus | < 0.001 | 0.005 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.005 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | < 0.001 | < 0.001 | 3.490 | 3.29 |
| 0006 | Bairdi | < 0.001 | 0.006 | < 0.001 | < 0.001 | < 0.001 | 0.012 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.006 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.021 | < 0.001 | 1.930 | 3.07 |
| 0006 | Hybrid | < 0.001 | 0.004 | < 0.001 | < 0.001 | < 0.001 | 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.004 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.033 | < 0.001 | 13.700 | 2.69 |
| 0006 | Cognatus | < 0.001 | 0.004 | < 0.001 | < 0.001 | < 0.001 | 0.024 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.004 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.127 | < 0.001 | 4.440 | 4.12 |
| 0007 | Cognatus | 0.002 | 0.011 | < 0.001 | < 0.001 | < 0.001 | 0.012 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.004 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | 0.012 | 0.039 | < 0.001 | 5.150 | 3.15 |
| 0002 | Cognatus | < 0.001 | 0.004 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.004 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.064 | < 0.001 | 1.860 | 3.45 |
| 0002 | Cognatus | < 0.001 | 0.003 | < 0.001 | < 0.001 | < 0.001 | 0.008 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.003 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.052 | 0.020 | 1.150 | 3.09 |
| 0002 | Cognatus | < 0.001 | 0.005 | < 0.001 | < 0.001 | < 0.001 | 0.015 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.005 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.107 | < 0.001 | 2.870 | 3.87 |
| 0004 | Cognatus | < 0.001 | 0.008 | < 0.001 | < 0.001 | < 0.001 | 0.015 | < 0.001 | < 0.001 | < 0.001 | < 0.010 | 0.008 | < 0.002 | < 0.001 | < 0.002 | NA | < 0.001 | < 0.01 | < 0.001 | 0.093 | < 0.001 | 4.090 | 3.21 |

< Lower than detection limit
NA Not available

TABLE 18: In-Place Pollutants Program

Sculpins - PAHs

Toronto Main STP

Units: ug/g

| Station | Biota | Phen- anthrene | Anth- racene | Flour- anthrene | Flourene | Pyrene | Benz- (a) an- thracene | Chrysene | Benzo- (e)- pyrene | Benzo- (B) | Benzoflouranthene BfI (J) | (K) | Perylene | Benzo (a)- Pyrene | Benzo- (ghi)- perylene | Dibenz- (a,h) an- thracene | Indeno- (1,2,3-cd) Pyrene | Benzo(b) chrysene | Anthran- Threne | Coro- nene | Dimethyl- Benz(a) anthracene |
|-----------|-----------------|-------------------|-----------------|--------------------|----------|--------|------------------------------|----------|--------------------------|---------------|---------------------------------|-------|----------|----------------------|------------------------------|----------------------------------|---------------------------------|----------------------|--------------------|---------------|------------------------------------|
| A. B. BAY | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| A. B. BAY | C. Bairdi | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| A. B. BAY | C. Cog.-C. Bair | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| A. B. BAY | C. Cog.-C. Bair | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| A. B. BAY | C. Bairdi HYB | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0005 | C. Bairdi | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0005 | C. Bairdi | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0001 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0001 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0001 | C. Bairdi | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0001 | C. Bairdi | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0003 | C. Cognatus | 0.087 | 0.130 | 0.000 | | 0.209 | 0.611 | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0006 | C. Bairdi | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0006 | Hybrid | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0006 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0007 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0002 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0002 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0002 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |
| 0004 | C. Cognatus | 0.002 | | 0.002 | | 0.003 | | 0.003 | 0.005 | 0.005 | NA | 0.005 | | 0.005 | 0.005 | 0.005 | 0.005 | | NA | 0.010 | NA |

BLANK LINES REFER TO BELOW DETECTION LIMITS, WITH NO LIMITS GIVEN

TABLE 19: In-Place Pollutants Program

1987 Toronto Main STP

Sculpins - Chlorinated Aromatics

Units: ug/g

| Station | Species | Hexa- chloro- ethane | 1,3,5 Tri- chloro- benzene | 1,2,4 Tri- chloro- benzene | 1,2,3 Tri- chloro- benzene | Hexa- chloro- buta- diene | 2,4,5 Tri- chloro- toluene | 2,3,6 Tri- chloro- toluene | 2,6a Tri- chloro- toluene | 1,2,3,5 Tetra- chloro- benzene | 1,2,4,5 Tetra- chloro- benzene | 1,2,3,4 Tetra- chloro- benzene | Penta- chloro- benzene | Toxaphene |
|---------------|-----------------|----------------------------|-------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|---|---|---|------------------------------|-----------|
| TRAP-LSP | C. Bairdi | 0.014 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| TRAP-LSP | C. Bairdi | < 0.001 | < 0.010 | < 0.010 | 0.013 | 0.013 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| SCUBA-LSP | C. Cognatus | < 0.001 | < 0.010 | < 0.010 | 0.015 | 0.015 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| SCUBA-LSP | C. Bairdi | 0.004 | < 0.010 | < 0.010 | 0.006 | 0.006 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.007 | < 0.001 | < 0.010 |
| TRAP A.B. BAY | C. Cognatus | 0.008 | < 0.010 | < 0.010 | 0.009 | 0.009 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.034 | 0.019 | < 0.010 |
| A.B. BAY | C. Cognatus | 0.011 | < 0.010 | < 0.010 | 0.012 | 0.012 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.019 | < 0.001 | < 0.010 |
| A.B. BAY | C. Bairdi | 0.011 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.019 | < 0.001 | < 0.010 |
| A.B. BAY | C. Cog.-C. Bair | 0.005 | < 0.010 | < 0.010 | 0.006 | 0.006 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| A.B. BAY | C. Cog.-C. Bair | < 0.001 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| A.B. BAY | C. Bairdi HYB | 0.008 | < 0.010 | < 0.010 | 0.007 | 0.007 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| 0005 | C. Bairdi | 0.004 | < 0.010 | < 0.010 | 0.004 | 0.004 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| 0005 | C. Bairdi | < 0.001 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.010 |
| 0001 | C. Cognatus | 0.013 | < 0.010 | < 0.010 | 0.017 | 0.017 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.025 | < 0.001 | < 0.010 |
| 0001 | C. Cognatus | 0.012 | < 0.010 | < 0.010 | 0.009 | 0.009 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.011 | < 0.001 | < 0.010 |
| 0001 | C. Bairdi | < 0.001 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | 0.005 | < 0.010 |
| 0001 | C. Bairdi | < 0.001 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | < 0.001 | 0.006 | < 0.010 |
| 0003 | C. Cognatus | 0.011 | < 0.010 | 0.067 | 0.010 | 0.010 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.021 | < 0.001 | < 0.010 |
| 0006 | C. Bairdi | 0.003 | < 0.010 | < 0.010 | 0.002 | 0.002 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.014 | < 0.001 | < 0.010 |
| 0006 | Hybrid | 0.005 | < 0.010 | < 0.010 | 0.008 | 0.008 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.017 | < 0.001 | < 0.010 |
| 0006 | C. Cognatus | 0.005 | < 0.010 | < 0.010 | 0.006 | 0.006 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.016 | 0.008 | < 0.010 |
| 0007 | C. Cognatus | 0.006 | < 0.010 | 0.038 | 0.008 | 0.008 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.019 | 0.016 | < 0.010 |
| 0002 | C. Cognatus | < 0.001 | 0.166 | < 0.010 | 0.043 | 0.043 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.019 | < 0.001 | < 0.010 |
| 0002 | C. Cognatus | 0.007 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.018 | < 0.001 | < 0.010 |
| 0002 | C. Cognatus | 0.008 | < 0.010 | < 0.010 | 0.011 | 0.011 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.036 | < 0.001 | < 0.010 |
| 0004 | C. Cognatus | 0.006 | < 0.010 | < 0.010 | < 0.005 | < 0.000 | NA | NA | < 0.010 | < 0.001 | < 0.001 | 0.025 | < 0.001 | < 0.010 |

< Less than detection limit

NA Not available

TABLE 20: In-Place Pollutants Program

1987 Toronto Main STP

Sculpins - Chlorophenols

Units: ug/g

| Station | Species | Trichlorophenol | | | | | Penta-chlorophenol |
|---------------|-----------------|-----------------|---------|---------|---------|---------|--------------------|
| | | 234 | 345 | 246 | 2345 | 2356 | |
| TRAP-LSP | C Bairdi | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.045 |
| TRAP-LSP | C Bairdi | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.049 |
| SCUBA-LSP | C Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.037 |
| SCUBA-LSP | C. Bairdi | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.027 |
| TRAP A B. BAY | C Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.031 |
| A B. BAY | C Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.031 |
| A B. BAY | C. Bairdi | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.027 |
| A B. BAY | C. Cog.-C. Bair | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.035 |
| A B. BAY | C. Cog.-C. Bair | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.024 |
| A B. BAY | C. Bairdi HYB | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.027 |
| 0005 | C. Bairdi | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.021 |
| 0005 | C. Bairdi | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.005 |
| 0001 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.046 |
| 0001 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.028 |
| 0001 | C. Bairdi | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.011 |
| 0001 | C. Bairdi | < 0.010 | < 0.010 | 0.009 | < 0.005 | 0.004 | 0.038 |
| 0003 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.055 |
| 0006 | C. Bairdi | < 0.010 | < 0.010 | 0.009 | < 0.005 | < 0.005 | 0.047 |
| 0006 | Hybrid | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.046 |
| 0006 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.046 |
| 0007 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.049 |
| 0002 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.035 |
| 0002 | C. Cognatus | < 0.010 | < 0.010 | 0.007 | < 0.005 | 0.005 | 0.038 |
| 0002 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.050 |
| 0004 | C. Cognatus | < 0.010 | < 0.010 | < 0.010 | < 0.005 | < 0.005 | 0.030 |

< Lower than detection limit

TABLE 21: In-Place Pollutants Program

Sediment Bioassay - Metals

Toronto Main STP, 1987

UNITS: ug/g, Wet Weight (Not corrected for gut content)

| LOCATION | STATION | ORGANISM | Al | As | Cd | Cr | Cu | Fe | Pb | Mn | Hg | Ni | Zn |
|---------------|-----------|----------|-----|--------|-------|------|-------|-----|-------|------|-------|--------|------|
| TORONTO (STP) | CONTROL | MAYFLIES | 342 | 0.62 | 0.321 | 1.28 | 1.96 | 589 | 1.33 | 33.1 | 0.008 | 0.59 | 25.9 |
| TORONTO (STP) | CONTROL A | FATHEADS | 68 | 0.17 | 0.241 | 0.67 | 7.99 | 144 | 0.35 | 5.3 | 0.234 | 0.32 | 46.0 |
| TORONTO (STP) | 8 | MAYFLIES | 256 | 0.50 | 0.813 | 5.44 | 14.10 | 695 | 10.90 | 10.9 | 0.042 | 1.36 | 47.4 |
| TORONTO (STP) | 8A | FATHEADS | 11 | 0.08 | 0.126 | 0.57 | 6.81 | 29 | 0.20 | 1.0 | 0.313 | 0.19 | 49.0 |
| TORONTO (STP) | 5 | MAYFLIES | 73 | 0.33 | 0.571 | 4.13 | 5.29 | 304 | 2.22 | 3.2 | 0.030 | 1.26 | 35.1 |
| TORONTO (STP) | 1 | MAYFLIES | 188 | 0.52 | 0.305 | 3.97 | 7.17 | 631 | 7.51 | 7.8 | 0.031 | 1.31 | 46.1 |
| TORONTO (STP) | 1C | FATHEADS | 79 | 0.26 | 0.260 | 1.88 | 11.73 | 235 | 1.40 | 6.0 | 0.248 | 0.74 | 73.7 |
| TORONTO (STP) | 3 | MAYFLIES | 170 | 0.44 | 0.370 | 5.27 | 7.33 | 525 | 3.82 | 8.1 | 0.049 | 1.74 | 40.3 |
| TORONTO (STP) | 3B | FATHEADS | 64 | < 0.05 | 0.341 | 1.22 | 8.93 | 194 | 0.93 | 3.7 | 0.298 | 0.14 | 48.3 |
| TORONTO (STP) | 12 | MAYFLIES | 149 | 0.64 | 0.338 | 1.02 | 3.41 | 279 | 0.64 | 8.6 | 0.019 | 0.87 | 28.3 |
| TORONTO (STP) | 12A | FATHEADS | 144 | 0.17 | 0.295 | 1.19 | 9.91 | 265 | 0.51 | 7.3 | 0.300 | 0.52 | 46.7 |
| TORONTO (STP) | 6 | MAYFLIES | 178 | 0.41 | 0.431 | 3.24 | 5.21 | 444 | 1.42 | 9.2 | 0.029 | 1.05 | 24.5 |
| TORONTO (STP) | 10 | MAYFLIES | 192 | 0.59 | 0.891 | 8.01 | 9.02 | 813 | 2.82 | 8.9 | 0.040 | 1.54 | 38.2 |
| TORONTO (STP) | 11 | MAYFLIES | 41 | 0.51 | 0.573 | 0.65 | 5.89 | 78 | 0.24 | 2.4 | 0.013 | 0.56 | 20.7 |
| TORONTO (STP) | 11B | FATHEADS | 20 | 0.20 | 0.183 | 0.46 | 8.82 | 40 | 0.12 | 1.3 | 0.363 | 0.30 | 44.3 |
| TORONTO (STP) | 7 | MAYFLIES | 207 | 0.66 | 0.842 | 5.59 | 7.85 | 652 | 2.21 | 10.7 | 0.039 | 1.45 | 33.4 |
| TORONTO (STP) | 2 | MAYFLIES | 190 | 0.41 | 0.306 | 5.00 | 7.75 | 592 | 3.05 | 8.6 | 0.026 | 1.42 | 35.3 |
| TORONTO (STP) | 2B | FATHEADS | 20 | < 0.05 | 0.221 | 0.64 | 11.57 | 44 | 0.44 | 2.4 | 0.392 | 0.25 | 76.5 |
| TORONTO (STP) | 9 | MAYFLIES | 170 | 0.53 | 0.517 | 1.22 | 3.37 | 333 | 1.71 | 19.9 | 0.015 | 0.65 | 25.0 |
| TORONTO (STP) | 9A | FATHEADS | 18 | 0.31 | 0.197 | 0.56 | 10.34 | 33 | 0.09 | 1.5 | 0.299 | < 0.10 | 36.4 |
| TORONTO (STP) | 9A | FATHEADS | 32 | 0.11 | 0.191 | 0.69 | 7.35 | 63 | 0.19 | 2.1 | 0.297 | 0.49 | 39.2 |
| TORONTO (STP) | 4 | MAYFLIES | 181 | 0.43 | 0.442 | 1.87 | 4.17 | 376 | 1.76 | 11.0 | 0.03 | 0.80 | 26.9 |
| TORONTO (STP) | 4A | FATHEADS | 22 | < 0.03 | 0.225 | 0.41 | 8.45 | 46 | 0.15 | 2.1 | 0.293 | 0.27 | 45.9 |

KEY: < Less than detection limit

TABLE 22: In-Place Pollutants Program

Toronto Main STP, 1987

Sediment Laboratory Bioassay - PCBs & Pesticides

| STATION | ORGANISM | WEIGHT(g) | % LIPID | % ASH | HCB | HEPTA CHLOR | HEPTA. EPOX. | ALDRIN | MIREX | a-BHC | B-BHC | d-BHC | ALPHA- CHLORDANE | GAMMA- CHLORDANE |
|-----------|----------|-----------|---------|-------|---------|----------------|-----------------|---------|---------|---------|---------|---------|---------------------|---------------------|
| CONTROL | MAYFLIES | 0.875 | 1.257 | 1.49 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| CONTROL A | FATHEADS | 0.932 | 4.432 | 4.15 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 8 | MAYFLIES | 0.466 | 1.202 | 2.66 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 8A | FATHEADS | 1.578 | 5.981 | 1.79 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 5 | MAYFLIES | 0.573 | 2.113 | 1.15 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 3 | MAYFLIES | 0.592 | 1.403 | 2.15 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 3C | FATHEADS | 1.317 | 3.486 | 3.36 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 12 | MAYFLIES | 0.475 | 1.643 | 1.45 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 12A | FATHEADS | 0.773 | 3.622 | 3.79 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 6 | MAYFLIES | 0.685 | 1.694 | 2.93 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 10 | MAYFLIES | 0.422 | 1.375 | 1.85 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 11 | MAYFLIES | 0.508 | 1.418 | 1.34 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 11B | FATHEADS | 1.290 | 1.806 | 3.20 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 7 | MAYFLIES | 0.293 | 2.080 | 4.60 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 2 | MAYFLIES | 0.810 | 1.135 | 1.67 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 2B | FATHEADS | 0.430 | 2.744 | 3.63 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 2B | FATHEADS | 0.462 | 2.445 | 3.61 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 9 | MAYFLIES | 0.422 | 1.586 | 1.89 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 9A | FATHEADS | 1.282 | 5.734 | 3.23 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 4 | MAYFLIES | 0.532 | 1.241 | 2.18 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| 4A | FATHEADS | 0.926 | 3.272 | 4.14 | < 0.001 | < 0.001 | < 0.002 | < 0.001 | < 0.002 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

TABLE 23: In-Place Pollutants Program

Toronto Main STP, 1987

Sediment Bioassay - Chlorinated Aromatics

UNITS: ug/g, Wet Weight (Not corrected for gut content)

| STATION | ORGANISM | HEXACHLORO -ETHANE | 135-TCB | 124-TCB | HEXACHLORO -BUTADIENE | 123-TCB | 1235-TCB | 1245-TCB | 26a-TCT | 1234-TCB | PENTACHLORO BENZENE | TOXAPHENE |
|-----------|----------|-----------------------|---------|---------|--------------------------|---------|----------|----------|---------|----------|------------------------|-----------|
| CONTROL | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| CONTROL A | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 8 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 8A | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 5 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 1 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 1A | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 3 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 3C | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 12 | MAYFLIES | < 0.001 | 0.024 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 12A | FATHEADS | < 0.001 | 0.015 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | 0.003 | 0.01 |
| 6 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 10 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 11 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 11B | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | 0.010 | < 0.001 | 0.01 |
| 7 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | 0.002 | 0.01 |
| 2 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 2B | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 2B | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 9 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 9A | FATHEADS | < 0.001 | < 0.010 | < 0.01 | 0.002 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | 0.002 | 0.01 |
| 4 | MAYFLIES | < 0.001 | < 0.010 | < 0.01 | 0.002 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |
| 4A | FATHEADS | < 0.001 | < 0.010 | < 0.01 | < 0.001 | < 0.005 | < 0.001 | < 0.001 | < 0.01 | < 0.001 | < 0.001 | 0.01 |

KEY: < Less than detection limit

- No data

**TABLE 24. Laboratory Sediment Bioassay Acute Toxicity Test Results
Toronto Main STP, 1987.**

| Station No. | Fathead Minnows | Mayflies |
|-------------|-----------------|----------|
| 0008 | 0 | 0 |
| 0005 | 93 | 7 |
| 0001 | 40 | 0 |
| 0003 | 20 | 0 |
| 0012 | 7 | 7 |
| 0006 | 100 | 10 |
| 0010 | 100 | 13 |
| 0011 | 13 | 0 |
| 0007 | 100 | 0 |
| 0002 | 67 | 0 |
| 0009 | 0 | 0 |
| 0004 | 20 | 0 |
| Control | 7 | 0 |

Numbers given are percent mortality over the ten day test period.

TABLE 25: Correlation of Metal Concentrations in Geochemical Fractions, Toronto Main STP, 1987.

Only those fractions that were highly correlated (at the 95% level) are listed.

| | Zn | Mn | Fe | As | Al | Cu | Cd | Cr | Pb | Ni |
|--------|-------|-------|----|--------|-------|-------|-------|-------|-------|-------|
| IW:F1 | | | | | | | | | | |
| IW:F2 | | | | | | | | | | |
| IW:F3 | | | | -.8597 | | | | | | |
| IW:F4 | | | | | | | | | | |
| IW:Res | | | | | | | | | | |
| F1:F2 | .6316 | .6154 | | .6776 | | .7385 | | | | |
| F1:F3 | | .6853 | | | | .6516 | | | .6871 | |
| F1:F4 | | | | | .6550 | .6504 | | | .6905 | |
| F1:Res | .6526 | | | .7924 | | .6504 | .7385 | | | .8620 |
| F2:F3 | .8182 | | | | | | | | | |
| F2:F4 | .8252 | | | .6879 | .5812 | | | | | |
| F2:Res | .6526 | | | .8601 | | | .7385 | .6805 | | |
| F3:F4 | .9301 | | | | | .8897 | .8221 | .9650 | .8348 | |
| F3:Res | .6434 | | | | .5734 | .6585 | .5965 | .6620 | | |
| F4:Res | .7552 | | | .8007 | | .7972 | .6594 | .7496 | .7491 | .6113 |

TABLE 26: Correlation Coefficients (Spearman Rank) for Sediment Metals and Organic Carbon and for Sediment Metals and Corresponding Invertebrate Tissue Levels (significance level in parentheses).

| | Sediment TOC July | Sediment TOC Oct. | Biota* Metal | Solvent** Extractables |
|--------------------|-------------------------|-------------------------|-------------------------|---------------------------|
| sediment copper | .9021 (.0028) | .8766 (.0036) | .2168 (.4721) | .9021 (.0028) |
| sediment chromium | .8252 (.0062) | .9366 (.0019) | .0490 (.8710) | .6294 (.0369) |
| sediment mercury | .6737 (.0255) | .8794 (.0035) | .1406 (.6410) | .7123 (.0182) |
| sediment cadmium | .7203 (.0169) | .9635 (.0014) | .0070 (.9815) | .6224 (.0390) |
| sediment iron | .8198 (.0065) | .6107 (.0428) | .0636 (.8329) | .3958 (.1893) |
| sediment lead | .7636 (.0113) | .7721 (.0104) | .6479 (.0316) | .7636 (.0113) |
| sediment zinc | .8811 (.0035) | .8766 (.0036) | -.1469 (.6262) | .7552 (.0122) |
| sediment arsenic | .8021 (.0078) | .8300 (.0059) | -.4211 (.1626) | .4448 (.1401) |
| sediment manganese | .3860 (.2005) | .6661 (.0271) | -.0421 (.8889) | -.0316 (.9166) |
| sediment aluminum | .6993 (.0204) | .8863 (.0033) | .0839 (.7808) | .2028 (.5012) |
| sediment nickel | .8246 (.0062) | .8313 (.0058) | -.2667 (.3765) | .3088 (.3058) |
| sediment TOC | | | | .4965 (.0996) |

* Biota = Invertebrate tissue levels of the corresponding metal (wet weight not corrected for gut contents)

** Solvent Extractables correlation data from July-August survey.

Correlations significant at the 95% levels appear in bold type.

TABLE 27: Correlation Coefficients (Spearman Rank) for Sediment Geochemical Fractions and Invertebrate Tissue Level (all calculations based on wet weight) (significance level in parentheses).

| | IW | F1 | F2 | F3 | F4 | Res | Bulk |
|-----------------|-------------------|-------------------|-------------------|-------------------|--------------------------|-------------------|-------------------------|
| biota zinc | -.0534 (.8594) | .3088 (.3058) | .0629 (.8346) | -.2517 (.4037) | -.3007 (.3186) | .2028 (.5012) | -.1469 (.6262) |
| biota manganese | .6831 (.0235) | .3147 (.2966) | .0559 (.8528) | .0839 (.7808) | -.3853 (.2013) | -.2140 (.4778) | .3776 (.2104) |
| biota aluminum | .0106 (.9720) | -.0070 (.9815) | .1177 (.6963) | .0140 (.9630) | -.1119 (.7106) | .0769 (.7986) | -.2797 (.3535) |
| biota arsenic | .6537 (.0302) | .0629 (.8349) | -.2837 (.3467) | -.4982 (.0984) | -.6820 (.0237) | -.2522 (.4029) | -.4448 (.1401) |
| biota iron | .0141 (.9627) | -.0699 (.8166) | .1538 (.6099) | .0559 (.8528) | .1329 (.6594) | .1119 (.7106) | -.0140 (.9630) |
| biota copper | -.0753 (.8028) | .1183 (.6949) | -.3057 (.3106) | .1751 (.5613) | .1329 (.6594) | .2517 (.4037) | .2452 (.4161) |
| biota lead | -.0276 (.9273) | .2829 (.3481) | .0226 (.9402) | .3169 (.2932) | .4233 (.1603) | .5614 (.0626) | .6479 (.0316) |
| biota chromium | -.0038 (.9900) | .4441 (.1408) | .0464 (.8778) | .5035 (.0949) | .4615 (.1258) | .1016 (.7362) | .2797 (.3535) |
| biota cadmium | -- | -.4804 (.1111) | -.4804 (.1111) | -.0670 (.8241) | -.0390 (.8971) | -.4139 (.1698) | -.1285 (.6700) |
| biota nickel | -.0623 (.8363) | -.2787 (.3554) | -.3042 (.3129) | -.1314 (.6630) | -.1745 (.5627) | -.4445 (.1405) | -.2351 (.4356) |

Correlations significant at the 95% level appear in bold type.

TABLE 28: DISTRIBUTION, DENSITY, AND BIOMASS ESTIMATES OF MAJOR MACROBENTHIC TAXA, TORONTO HARBOUR, JULY, 1987.

All values are expressed on a square meter. Biomass calculated on wet weight basis.

| | Station 0008 | | Station 0005 | | Station 0001 | | Station 0003 | | Station 0012 | | Station 0006 | |
|--------------------------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|
| | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) |
| ARTHIROPODA | | | | | | | | | | | | |
| Class Insecta | | | | | | | | | | | | |
| O. Diptera | | | | | | | | | | | | |
| F. Chironomidae | | | 149 | 0.0273 | 15 | 0.0008 | 53 | 0.0137 | 747 | 0.7213 | 19 | 0.010 |
| Class Crustacea | | | | | | | | | | | | |
| O. Amphipoda | | | 4 | 0.0017 | | | | | | | | |
| O. Isopoda | | | | | | | | | | | | |
| MOLLUSCA | | | | | | | | | | | | |
| Class Gastropoda | | | | | | | | | | | | |
| Class Pelecypoda | | | | | | | | | | | | |
| ANNELIDA | | | | | | | | | | | | |
| Class Oligochaeta | 7,784 | 9.8241 | 71,567 | 22.4868 | 93,097 | 30.2432 | 20,421 | 6.9133 | 6,252 | 2.5116 | 12,785 | 6.5787 |
| TOTAL # ORGANISMS | 7,784 | | 71,720 | | 93,112 | | 20,474 | | 6,999 | | 12,804 | |
| TOTAL BIOMASS | | 9.8241 | | 22.5158 | | 30.2440 | | 6.927 | | 3.2329 | | 6.5887 |
| CORRECTED BIOMASS (+ 10%) | | 10.8065 | | 24.7674 | | 33.2684 | | 7.6197 | | 3.5562 | | 7.2476 |

TABLE 28: Continued.

All values are expressed on a square meter basis. Biomass is calculated on a wet weight basis.

| | Station 0010 | | Station 0011 | | Station 0007 | | Station 0002 | | Station 0009 | | Station 0004 | |
|--------------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------|
| | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) | Average # Organisms | Biomass (gms) |
| ARTHROPODA | | | | | | | | | | | | |
| Class Insecta | | | | | | | | | | | | |
| O. Diptera | | | | | | | | | | | | |
| F. Chironomidae | 115 | 0.1856 | 8,596 | 3.2375 | 65 | 0.0098 | 161 | 0.0364 | 506 | 0.2696 | 88 | 0.0376 |
| Class Crustacea | | | | | | | | | | | | |
| O. Amphipoda | | | 19 | 0.0110 | | | 19 | 0.0015 | 555 | 0.3315 | 61 | 0.0249 |
| O. Isopoda | | | | | | | | | | | | |
| MOLLUSCA | | | | | | | | | | | | |
| Class Gastropoda | | | | | | | | | | | | |
| Class Pelecypoda | | | 31 | 0.0826 | | | | | 299 | 0.7185 | 19 | 0.0266 |
| ANNELIDA | | | | | | | | | | | | |
| Class Oligochaeta | 42,733 | 14.7366 | 32,583 | 8.2114 | 30,032 | 8.3672 | 14,062 | 7.7909 | 14,878 | 12.4963 | 5,190 | 3.8683 |
| TOTAL # ORGANISMS | | | | | | | | | | | | |
| | 42,848 | | 41,229 | | 30,097 | | 14,242 | | 16,238 | | 5,358 | |
| TOTAL BIOMASS | | | | | | | | | | | | |
| | | 14.9222 | | 11.5425 | | 8.3770 | | 7.8288 | | 13.8159 | | 3.9574 |
| CORRECTED BIOMASS | | | | | | | | | | | | |
| (+ 10%) | | 16.4 | | 12.7 | | 9.2 | | 8.6 | | 15.2 | | 4.4 |

TABLE: 29: BENTHIC MACROINVERTEBRATE TAXA OF THE TORONTO WATERFRONT, JULY, 1987

| | STATION NUMBER (#/m ²) | | | | | | | | | | | |
|-------------------------------------|------------------------------------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|-------|
| | 0008 | 0005 | 0001 | 0003 | 0012 | 0006 | 0010 | 0011 | 0007 | 0002 | 0009 | 0004 |
| DIPTERA | | | | | | | | | | | | |
| Chironomidae | | | | | | | | | | | | |
| Chironominae | | | | | | | | | | | | |
| Chironomus sp. | | | | | | 19 | | 843 | 38 | | | |
| Chironomus plumosus grp. | | | 38 | | 766 | | 115 | | | 19 | | |
| Phaenopsectra sp. | | | | | | | | | | | 441 | |
| Microtendipes sp. | | | | | | | | | | | 77 | |
| Polypedilum | | | | | | | | | | | | |
| (Pentapedilum) sp | | | | | 115 | | | | | 96 | | 38 |
| Tanytarsus sp. | | | | | | | 38 | 8,312 | | | 115 | 38 |
| Orthocladiinae | | | | | | | | | | | | |
| Cricotopus festivellus grp. | | | | 38 | | | | | 77 | 77 | 38 | |
| Prodiamesinae | | | | | | | | | | | | |
| Monodiamesa depectinata | | | | | | | | | | | 38 | |
| Tanypodinae | | | | | | | | | | | | |
| Procladius sp. | | | | | 38 | | | | | | 38 | |
| AMPHIPODA | | | | | | | | | | | | |
| Haustoridae | | | | | | | | | | | | |
| Pontoporeia hoyi | | | | | | | | | | | 804 | 77 |
| PELECYPODA | | | | | | | | | | | | |
| Sphaeriidae | | | | | | | | | | | | |
| Pisidium casertanum | | | | | | | | | | | 383 | |
| OLIGOCHAETA | | | | | | | | | | | | |
| Tubificidae | | | | | | | | | | | | |
| Limnodrilus hoffmeisteri | 2,452 | 10,955 | 26,661 | 15,878 | 306 | 8,255 | 1,954 | 10,879 | 8,542 | 3,888 | | 1,685 |
| L. udekemianus | 498 | 4,903 | 2,643 | | | | 3,907 | 2,183 | 2,145 | 900 | | 96 |
| L. cervix | 1,302 | 6,129 | | | | 1,130 | 1,954 | | | | | 96 |
| L. clapedianus | | | | | | | | | | 2,088 | | |
| Tubifex tubifex | | | | | | 2,624 | | 3,256 | 2,145 | 594 | 613 | |
| Potamothrix vej dovskyi | | | | | | | | 2,183 | | | 919 | |
| P. moldaviensis | | | | | 306 | | | 2,183 | | 306 | 3,965 | 268 |
| Quistadrilus multisetosus | | 2,452 | | | | | | | | | | |
| immatures with capilliform setae | | 1,226 | | 1,628 | 306 | 383 | 1,954 | 7,623 | 728 | 594 | 919 | |
| immatures without capilliform setae | 2,452 | 52,403 | 65,427 | 2,854 | 5,171 | 383 | 54,586 | 15,246 | 20,647 | 1,781 | 6,397 | 2,298 |
| Naididae | | | | | | | | | | | | |
| Nais sp. | | | | 402 | | | | | | | | |
| Ophidonais serpentina | | | | 402 | | | | | | 1,494 | | |
| Pristinella jenkiniae | | | | | | | | 1,073 | | | | |
| Total Number of Organisms | 6,704 | 78,221 | 94,769 | 21,202 | 7,008 | 12,794 | 64,508 | 53,781 | 34,322 | 11,894 | 14,747 | 4,500 |
| Species Diversity (H') | 1.797 | 1.588 | 1.030 | 1.219 | 1.402 | 1.501 | 0.927 | 2.810 | 1.588 | 2.760 | 2.389 | 1.601 |
| Species Richness (S.R.) | 0.341 | 0.533 | 0.262 | 0.502 | 0.678 | 0.529 | 0.542 | 0.826 | 0.575 | 1.279 | 1.250 | 0.713 |
| Evenness (J') | 0.899 | 0.566 | 0.515 | 0.472 | 0.499 | 0.581 | 0.330 | 0.846 | 0.566 | 0.747 | 0.649 | 0.570 |

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